Chemical Engineering

JUNE 1954

HOW TO CUT YOUR
Bagging Costs
PAGE 234

Automation
AFFECTS MANAGEMENT
PAGE 225

Theory & practice
Equipment principles
Equipment selection
Batch vs. continuous

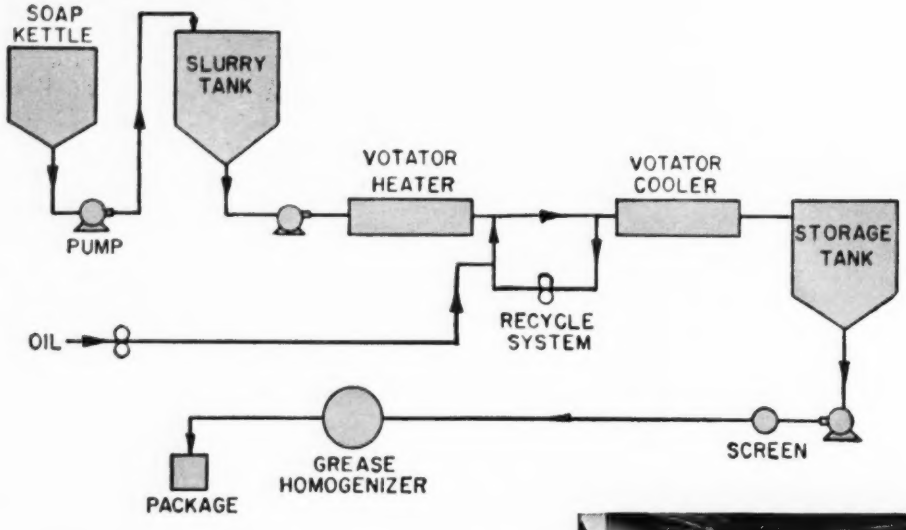
MIXING

A McGRAW-HILL PUBLICATION

ONE DOLLAR

Votator®
GREASE MAKING APPARATUS

cuts costs...improves uniformity ...eliminates fire hazard

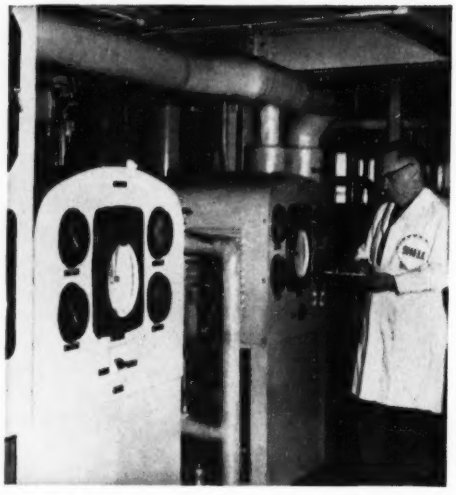


BY SWITCHING from the open kettle method to semi-continuous processing of lithium hydroxystearate grease the Martinez, California plant of Shell Oil Company has met expanding market demands and has obtained important cost-saving results. Heart of their new process is VOTATOR* Continuous Heat-transfer Apparatus for heating, mixing and cooling as shown in the above flow diagram. Modifications of this process are used by Shell in production of lithium stearate and aluminum stearate greases. The outstanding advantages:

- **Higher production rate.**
- **Lower labor costs.**
- **Lower soap costs.**
- **Enclosed processing system permits use of low-flash oils without fire hazard.**
- **Product consistency and color are uniform.**
- **Less floor area required.**

Investigate the advantages of VOTATOR Heat-transfer Apparatus for heating, crystallizing, controlling heat of reaction, emulsification, and sulfonation. Write today for complete 32-page booklet describing various continuous processing systems. The Girdler Company, Votator Division, Louisville 1, Kentucky.

*VOTATOR—Trade Mark Reg. U. S. Pat. Off.



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A DIVISION OF NATIONAL CYLINDER GAS COMPANY

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GAS PROCESSES DIVISION: New York, Tulsa, San Francisco.
In Canada: Girdler Corporation of Canada Limited, Toronto

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GIRDLER **BUILDS** processing plants
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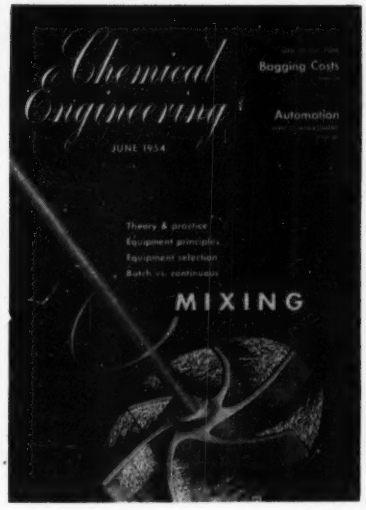
Sulfation	Chemicals	Paraffin Wax
Nitration	Textile Size	Synthetic Wax
Crystallization	Shaving Cream	Resins

Lubricating Grease And other Products

GUIDED TOUR

JOHN R. CALLAHAM, EDITOR



. . . Mixing today calls for hard facts and sharp engineering.

So here's our special 48-page roundup on the practical aspects of mixing as a unit operation.

It covers the mixing of liquids, pastes, plastics and dry solids both as batch and as continuous operations. It touches on theory but hits hardest at industry practice and equipment selection. You'll find it full of down-to-earth data. (p. 177)

Want to get ahead?

Of course you do, just like all the rest of us.

You won't get very far without sound engineering know-how. But technical competence alone is no open sesame to success.

"Thou shalt not—cannot—live by engineering alone." True?

There's where CE comes in with practical, "how-to-get-ahead" tips every month. I'm referring, of course, to our You & Your Job department.

There's nothing profound about You & Your Job. Nothing pretentious, nothing "professional." Nothing pompous, either. Just common sense, hard-headed advice.

Like how to write an effective letter, a better report. Or how to use operations research, to put semantics to work, to set yourself up as a chemical jobber—or how to handle an "ornery" associate!

Or like this month's tips on how to get your young engineers off on the right foot. You'll find the low-down from CE on p. 260.—JRC.

Where maintenance is really tough.

That's when you're in the business of processing nuclear chemicals—like the engineers up at Hanford. Now you can learn why they fight for mechanical simplicity, leakage control, no valves. (p. 230)

When should you use sorption drying?

After a thorough economic study tells you it's better than cooling-condensation for your particular drying problem. Here's

Please turn page

GUIDED TOUR

some mighty sound advice on how to make your own comparative analysis. (p. 237)

Managing tomorrow's automatic plant.

What effect will automation have on chemical management? Plenty, says Monsanto's Charles Knight, who goes on to show why the very structure of management must be steamlined to the core. (p. 225)

Down with bagging costs!

They're pesky, sure. But you can make real dollar savings if you go after them in earnest. Engineer Burke, who knows the ins and outs of bagging operations, spells out the tricks that bag the dollars. (p. 234)

Build a fume scrubber for $700.

Here're the details on how to convert an old wood stave tank into an efficient acid fume scrubber that'll handle up to 7,000 cfm of dilute HCl fumes. It's a Plant Notebook prize winner. (p. 252)

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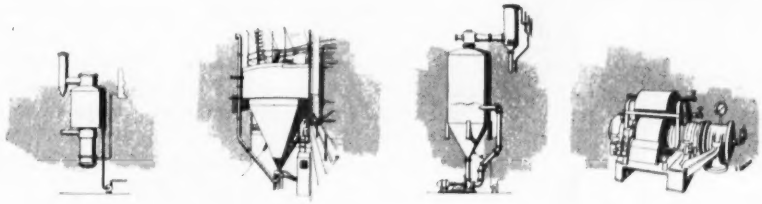

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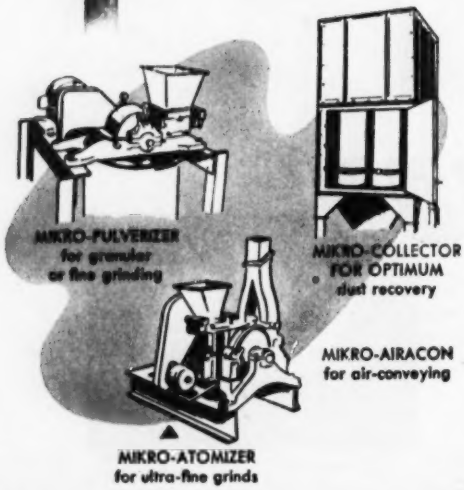
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55 CHATHAM ROAD — SUMMIT, NEW JERSEY

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The Marley Company

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Founder Member
Cooling Tower Institute

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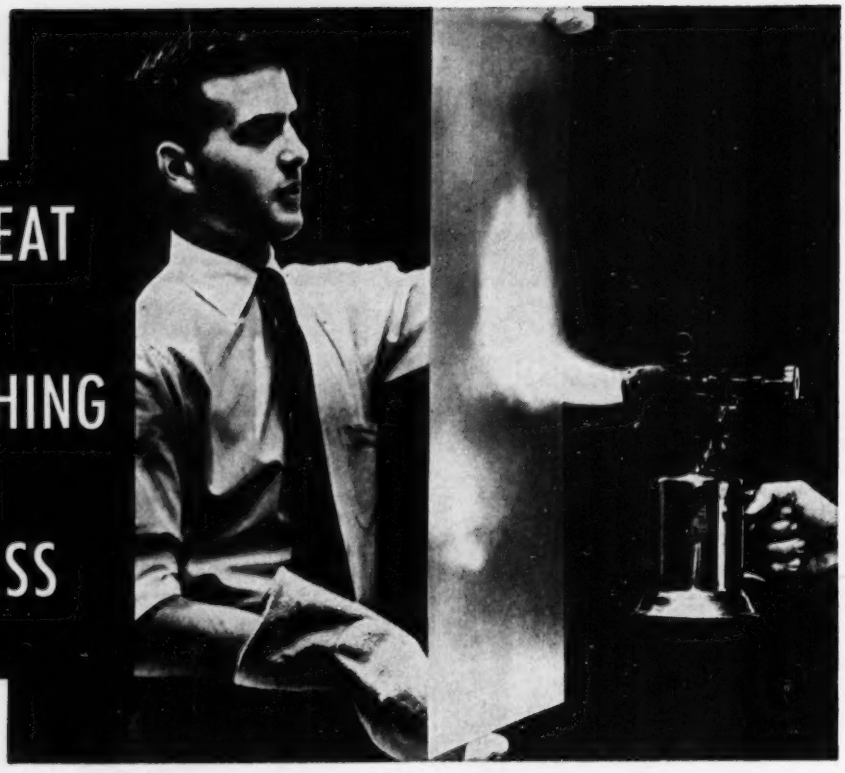

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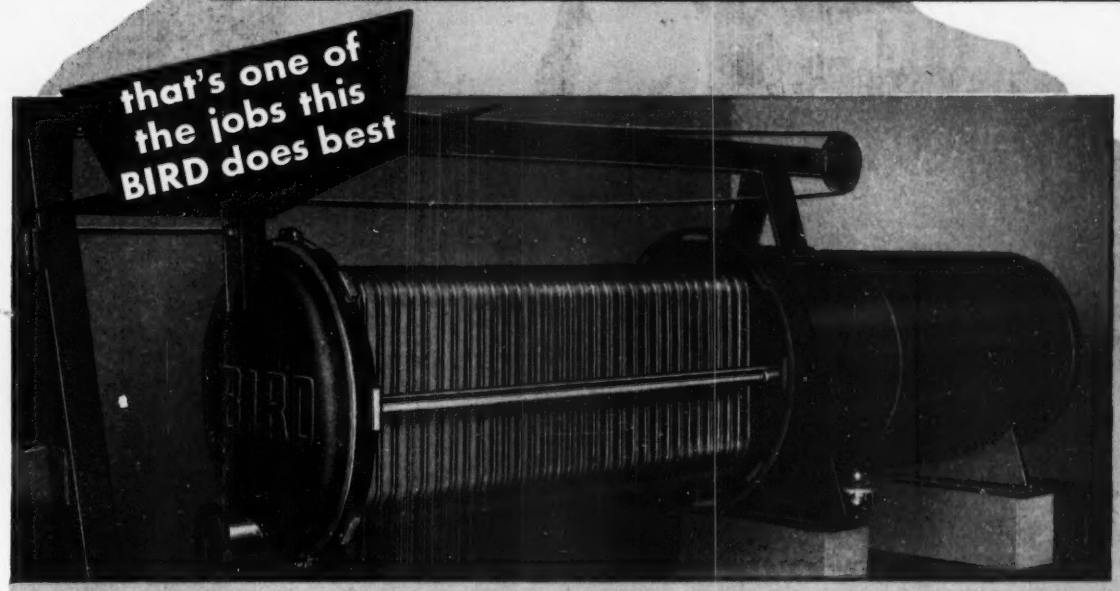

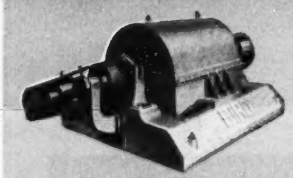

BIRD CENTRIFUGAL FILTER

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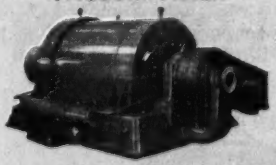

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If you want the true facts and figures in advance of your investment, **better bring it to BIRD.**

*See pages 14—15 for an IMPORTANT ANNOUNCEMENT

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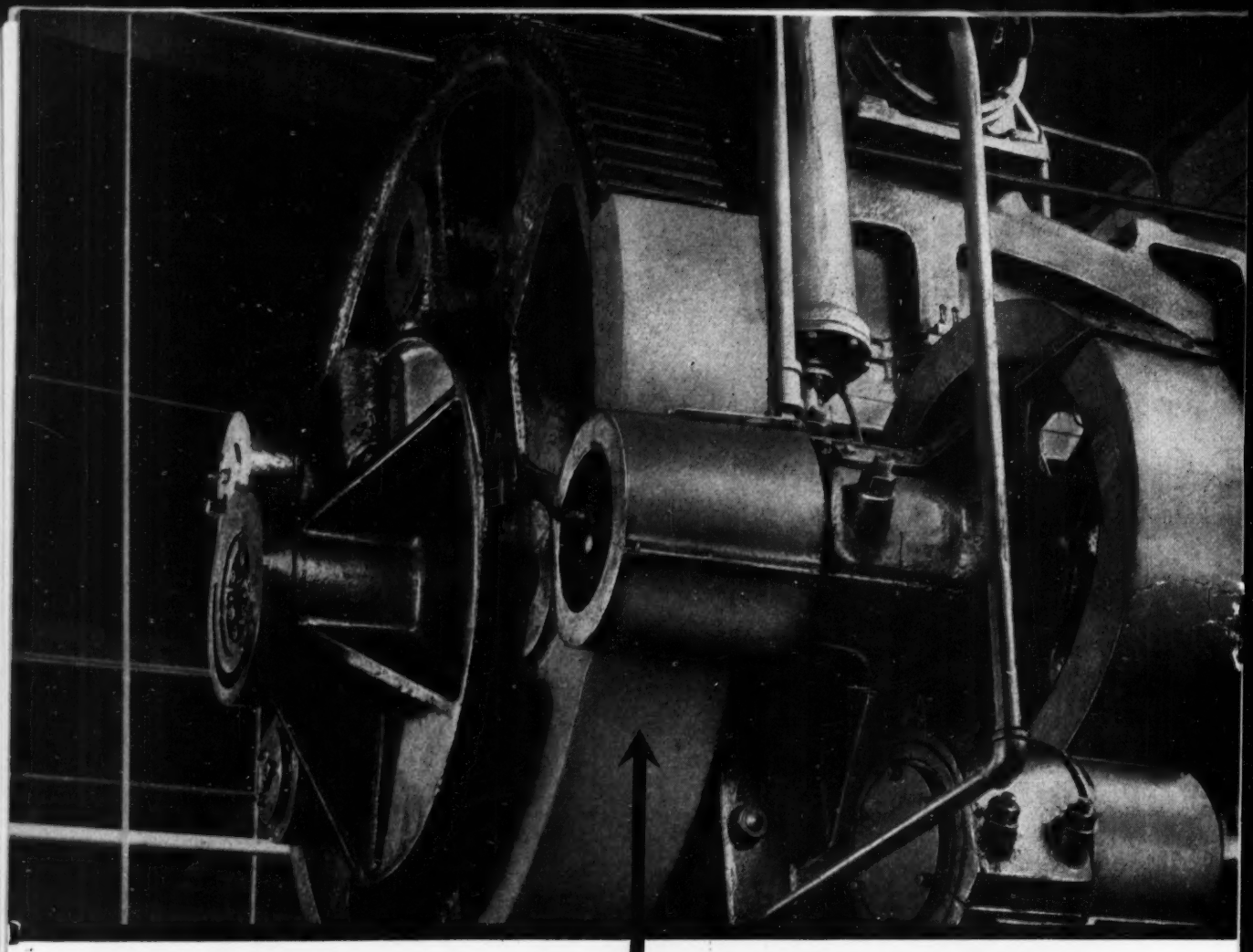

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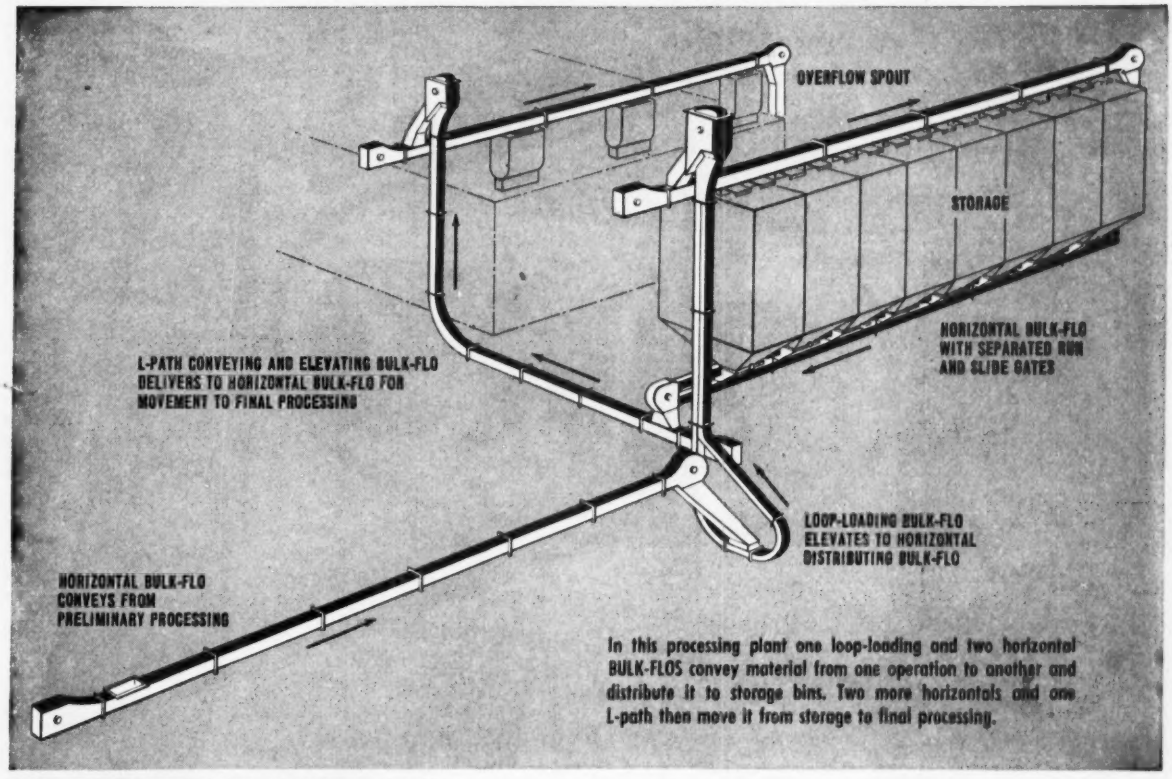
OVERFLOW SPOUT
STORAGE
HORIZONTAL BULK-FLO WITH SEPARATED RUN AND SLIDE GATES
L-PATH CONVEYING AND ELEVATING BULK-FLO DELIVERS TO HORIZONTAL BULK-FLO FOR MOVEMENT TO FINAL PROCESSING
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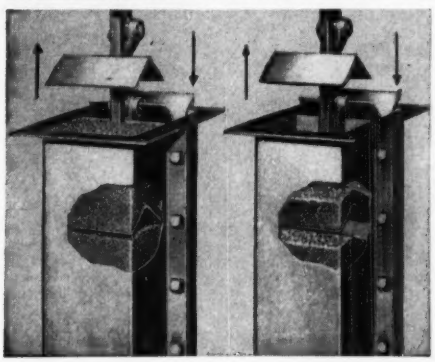
In this processing plant one loop-loading and two horizontal BULK-FLOS convey material from one operation to another and distribute it to storage bins. Two more horizontals and one L-path then move it from storage to final processing.



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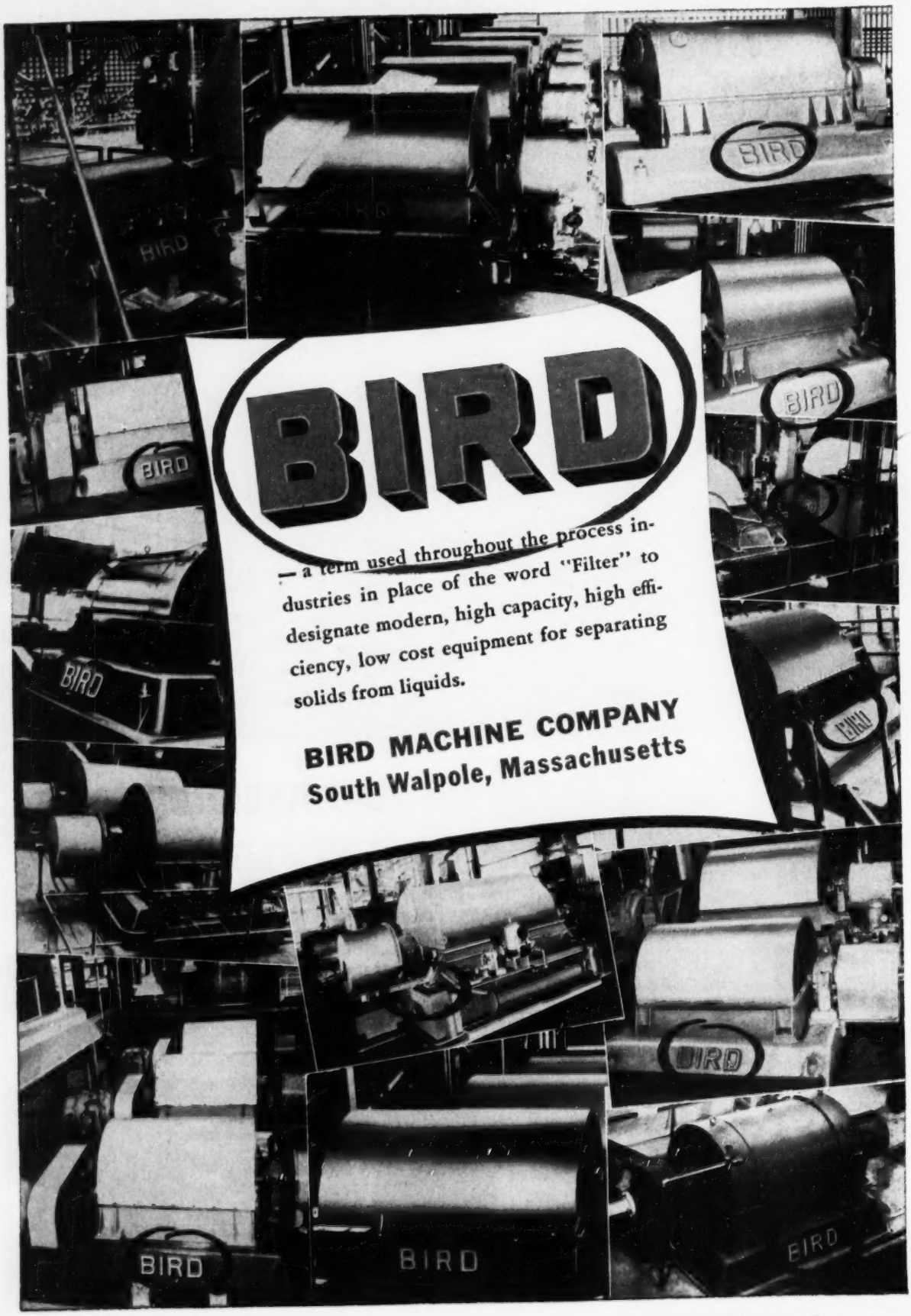
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— a term used throughout the process industries in place of the word "Filter" to designate modern, high capacity, high efficiency, low cost equipment for separating solids from liquids.
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South Walpole, Massachusetts

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of any of these products (or any having similar characteristics), is successfully and economically accomplished by

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Ammonium Sulphate
Aniline Sludge
Asphalt
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Barium Chloride
Barium Sulphate
Beryllium Sulphate
Black Ash
Borax
Butyl Acetate
Butyl Polymer
Calcium Carbonate
Calcium Nitrate
Carborundum
Carboxymethyl Cellulose
Carnallite
Cellulose Acetate
Chromium Oxide
Coal, bituminous and anthracite
Coffee
Copper Sulphate
Copperas
Corundum
Cryolite
Di-Sodium Phosphate
Ethyl Cellulose
Feldspar
Fish Meal
Flotation Concentrates
Flotation Tails
Fluorspar
Foundry Sands
Garnet
Gland Extracts
Glauber's Salt
Glutamic Acid
Hexachlorethane
Hexamine
Iron Ore
Iron Oxide
Langbeinite
Lead Arsenate
Lead Chromate
Lime
Lime Mud
Lithium Carbonate
Lithium Hydroxide
Lithopone
Manganese Ore
Manganese Salts
Methyl Cellulose
Mica
Nickel Salts
Packing House Waste
Perchlorates
Phenol
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Polyvinyl Alcohol
Polyvinyl Chloride
Potassium Carbonate
Potassium Chloride
Potassium Hydroxide
Potassium Nitrate
Potassium Sulphate
Potato Starch
Sodium Bichromate
Sodium Carbonate
Sodium Chloride
Sodium Fluoride
Sodium Hydroxide
Sodium Nitrate
Sodium Nitrite
Sodium Stannate
Sodium Sulphate
Sodium Sulphite
Sodium Thiosulphate
Solvent Extractions
Starches
Sulfur
Synthetic Resins
Tallow
Tartaric Acid
Tin Ore
Titanium Dioxide
Tri-Sodium Phosphate
Tungsten Salts
Ultramarine Pigment
Vinyl Acetate
Vinyl Chloride
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Xylenes
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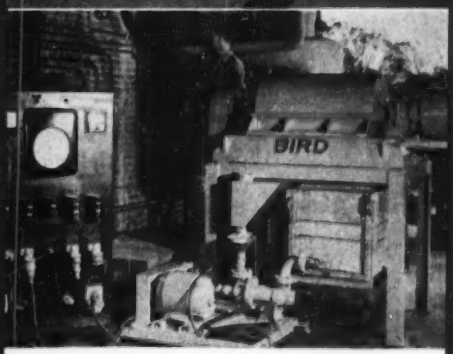
on filtration performance, capacity and cost are most reliably and promptly obtained at the

BIRD RESEARCH and DEVELOPMENT CENTER



This test plant is completely staffed and equipped to make pilot scale runs and provide accurate, dependable performance facts and figures *in advance* of your investment in filtration equipment.

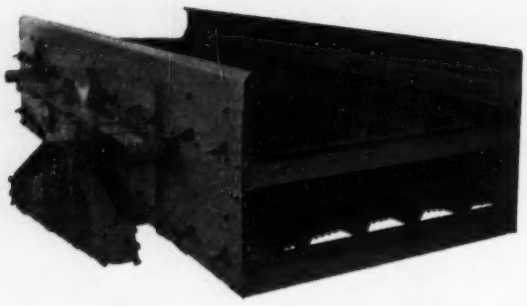
Bird builds vacuum filters, pressure filters and suspended centrifugals as well as centrifugal solid bowl and screen filters, so is in a position to provide unbiased recommendations.

Use these comprehensive facilities not only to get data on new separation problems but to determine the efficiency and up-to-dateness of your present filtering operations.

HEWITT HR ROBINS can cut your handling costs

with this complete

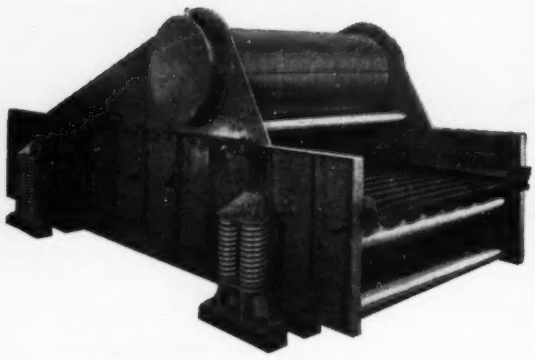
FOR SCREENING



GYREX°

Positive Stroke 4-Bearing Screens

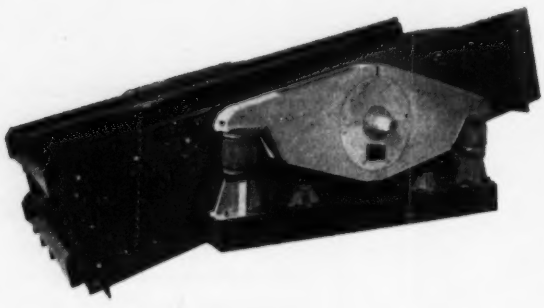
STROKES: ¼" at 1,000 r.p.m. and ½" at 625 r.p.m.
SIZES: Complete range of standard sizes from 48" x 78" to 72" x 192".
DECKS: Single—Double—Triple.
MOUNTINGS: Anvil-type cast iron base with *exclusive angle adjustment* for floor mounting—Steel I-beam base for suspended or rigid mounting.



ELIPTEX°

Horizontal Operating Flat Screens

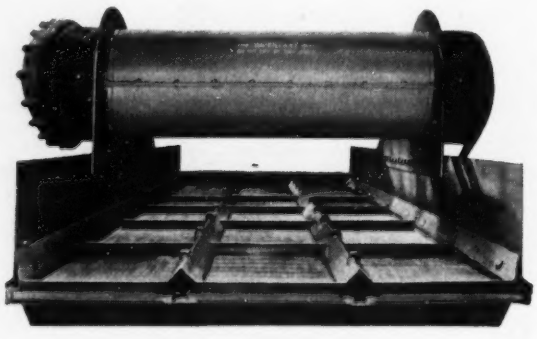
STROKES: 7/16" nominal at 1,000 r.p.m.—Other stroke and speed combinations available to meet special applications.
SIZES: All standard sizes from 36" x 96" to 72" x 240".
DECKS: Single—Double—Triple.
MOUNTINGS: Floor mounted or Suspended arrangement.



VIBREX°

Full-Floating, Unbalanced Pulley-Type 2-Bearing Screens

STROKES: Available in many stroke and speed combinations ranging from 1/16" at 1,800 r.p.m. to ½" at 660 r.p.m. —All Vibrex screens have readily adjustable stroke to meet the most exacting operating conditions.
SIZES: All standard sizes from 16" x 30" to 72" x 192".
DECKS: Single—Double—Triple.
MOUNTINGS: *Exclusive angle adjustment* for floor mounting —Cable arrangement for suspended mounting.



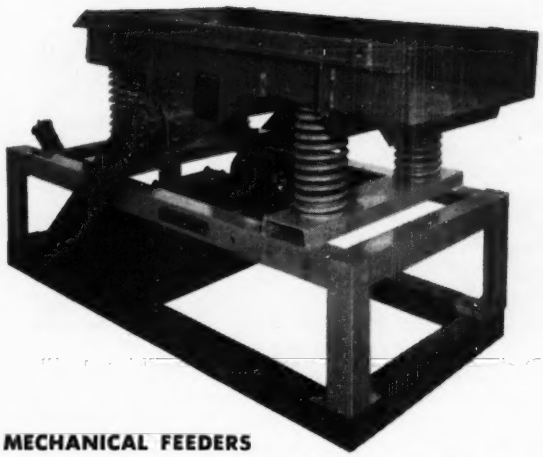
ELIPTEX DEWATERIZER

Specially Designed Eliptex Screen With Micron-Size Opening Stainless Steel Flat Rod Deck

STROKE: Extra-full stroke operating at high speed for maximum efficiency to handle even the most difficult dewatering problems.
SIZES: All standard sizes from 36" x 144" to 72" x 192".
DECKS: Single—Double.
MOUNTINGS: Same as Eliptex Screens.

line of Vibrating Equipment

FOR FEEDING & CONVEYING



MECHANICAL FEEDERS

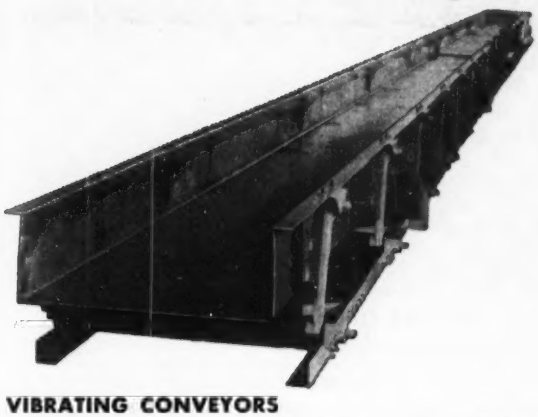
A *fully mechanical* vibrating feeder that is easily maintained by your own personnel. Extremely high capacities at very low power consumption.

FEED CONTROL: Remote, wide range, variable speed controls available.

STROKE: Full 3/16" at 1,000 r.p.m. readily adjustable . . . ideal for handling material of varying characteristics.

SIZES: All standard sizes from 24" x 48" to 48" x 96".

MODELS: Standard—Heavy duty models and special pans and deck designs available . . . suspended or base mountings.



VIBRATING CONVEYORS

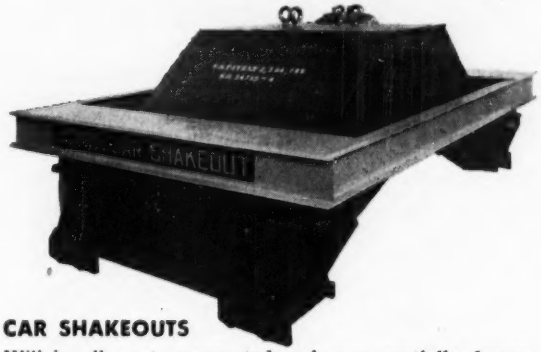
A continuously balanced vibrating conveyor offering longer units with higher capacities at lower horsepower than ever before available. Ideal for handling a wide range of materials be it wet or dry, lump or pulverized, packaged or loose, hot or cold, abrasive or corrosive.

SIZES: Standards from 8" to 48" wide up to 150' long with single drive.

STROKE: Full strokes from 1/4" to 3/8" at speeds of approximately 750 r.p.m.

MODELS: Standard—Heavy duty models and special pan designs and arrangements available.

FOR SHAKING OUT



CAR SHAKEOUTS

Will handle wet, compacted and even partially frozen loads. Capacities vary depending upon characteristics of material . . . Typical unloading time under 5 minutes per car.

MODELS: 5-Ton HD (Heavy-Duty) for handling up to 100 cars per day—3½-Ton GS (General Service) generally recommended for up to 10 cars per day. Both models available with companion twin-hook Car Shakeout Hoist.

STROKE: 5/32" at 1,500 vibrations per minute (easily adjusted for specific applications).

Patent No. 2,504,789

FOUNDRY SHAKEOUTS

Successfully used in steel, iron and non-ferrous foundries of all types (production and jobbing) handling castings weighing from a few ounces up to 60 tons.

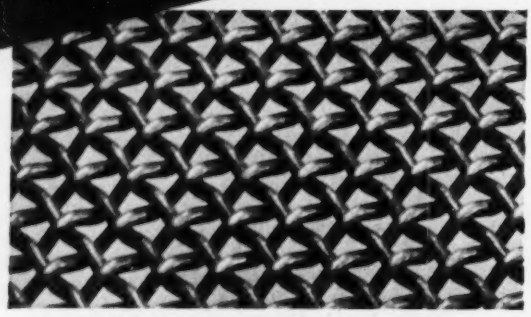
SIZES: From 2' x 2' to 8' x 10' in single units. Multiple unit arrangements up to 16' x 33'.

CAPACITIES: Up to 300,000 # (150 tons) in multiple units.

STYLES: Standard Stationary, Portable, Gravity Self-Discharging and Mechanical (Horizontal) Self-Discharging.

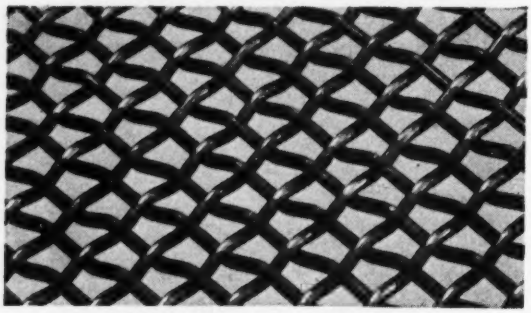
AND FOR YOUR SCREEN CLOTH NEEDS

HEWITT HR ROBINS
can cut your handling costs
with a complete



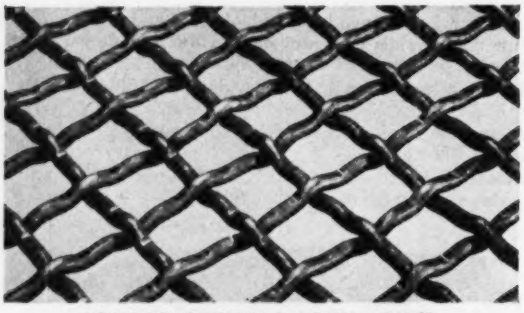
SQUARE OPENING DOUBLE CRIMP

All wires are specially crimped so that a spring tension permanently locks them together at each intersection. This guarantees tightness of weave and accurate sizing because openings cannot vary.



RECTANGULAR OPENING

Recommended for high speed sizing where accuracy is secondary. Rectangular weave provides greater open area hence higher capacity. Furnished with double crimp or flat top weave.

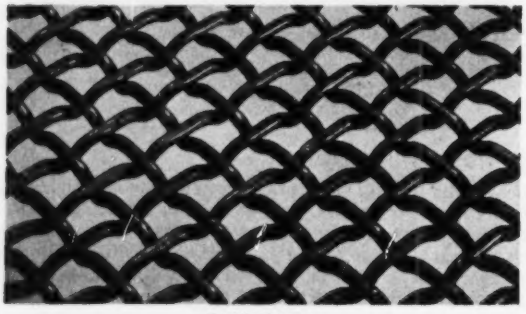


SQUARE OPENING LOCK CRIMP

Ideal for scalping. Has additional crimp to lock wires together under pressure to prevent wires from shifting as a result of impact and handling of oversize materials.

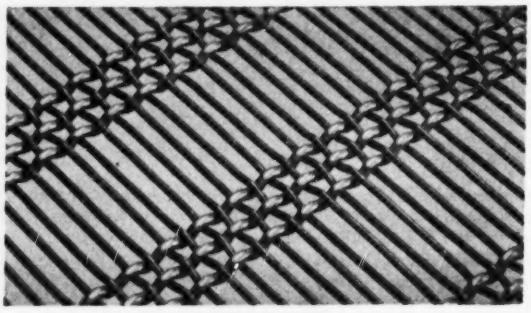
NON-SPREADER

Best for high speed sizing of coarse materials. Heavy-duty wires assist in maintaining accuracy of opening even under impact of wedge-shaped stone and over-sized materials.



FLAT TOP

Crimp characteristics provide smooth screening surface. Absence of high spots, as in other types of crimp, permits free flow and reduces abrasive action of material. Assures longer wear, faster screening and less degradation.



NON-BLIND

Recommended for processing moisture-laden materials that plug or blind openings. Slotted openings kept free from blinding due to secondary vibration set up in longer span wires. Clustered wires carry heavy tension and are crimped to maintain width of opening.

line of Screen Cloth

Each Type of Hewitt-Robins Screen Cloth is Specially Engineered To Accurately Size Large Tonnages . . . Last Longer . . . Cut Your Screening Costs

Hewitt-Robins Screen Cloth guarantees overall sizing accuracy through precision-weaving of individual screen cloth wires. You get longer service because Hewitt-Robins utilizes a full range of metals in its selection of wire to assure that each panel of screen cloth is matched to meet individual job requirements. Types of wire range from genuinely oil-tempered through spring steel, stainless steel, enamel-coated and on to special alloys of extraordinary corrosion and heat resistant properties.

In specific installations where the more abrasive materials such as coke, iron ore, stone, gravel and coal are handled, specify Hewitt-Robins Super-Gyraloy. It's the specially treated oil-tempered wire that combines hardness—stiffness—elasticity—ductility—toughness . . . and must pass exacting laboratory tests for uniformity of these properties.

For operations involving a dust factor aggravated by moisture (as in sizing fine coke and iron ore) specify Hewitt-Robins Super-Gyraloy Enamel Coated Screen Cloth. The enamel coating prevents the build-up of the blinding compound . . . protects the surface against moisture and averts oxidation of the metal.

Where initial cost is of primary consideration and abrasion is not excessive, Hewitt-Robins Gyraloy® spring steel screen cloth provides maximum efficiency and economy. For special applications Hewitt-Robins Screen Cloth comes in plain or galvanized steels, brass, phosphor-bronze, Monel and other ductile alloys.

Hewitt-Robins Screen Cloth is available in standard production size openings from 3/16" and coarser . . . wire sizes from .105" diameter up to and including 1" diameter.

For complete information regarding the kind, type and opening of Hewitt-Robins Screen Cloth to best fit your operation . . . give you highest screening efficiency at lowest cost per ton . . . contact Hewitt-Robins Incorporated, Robins Conveyors Division, 270 Passaic Avenue, Passaic, New Jersey, or your nearest Hewitt-Robins representative.

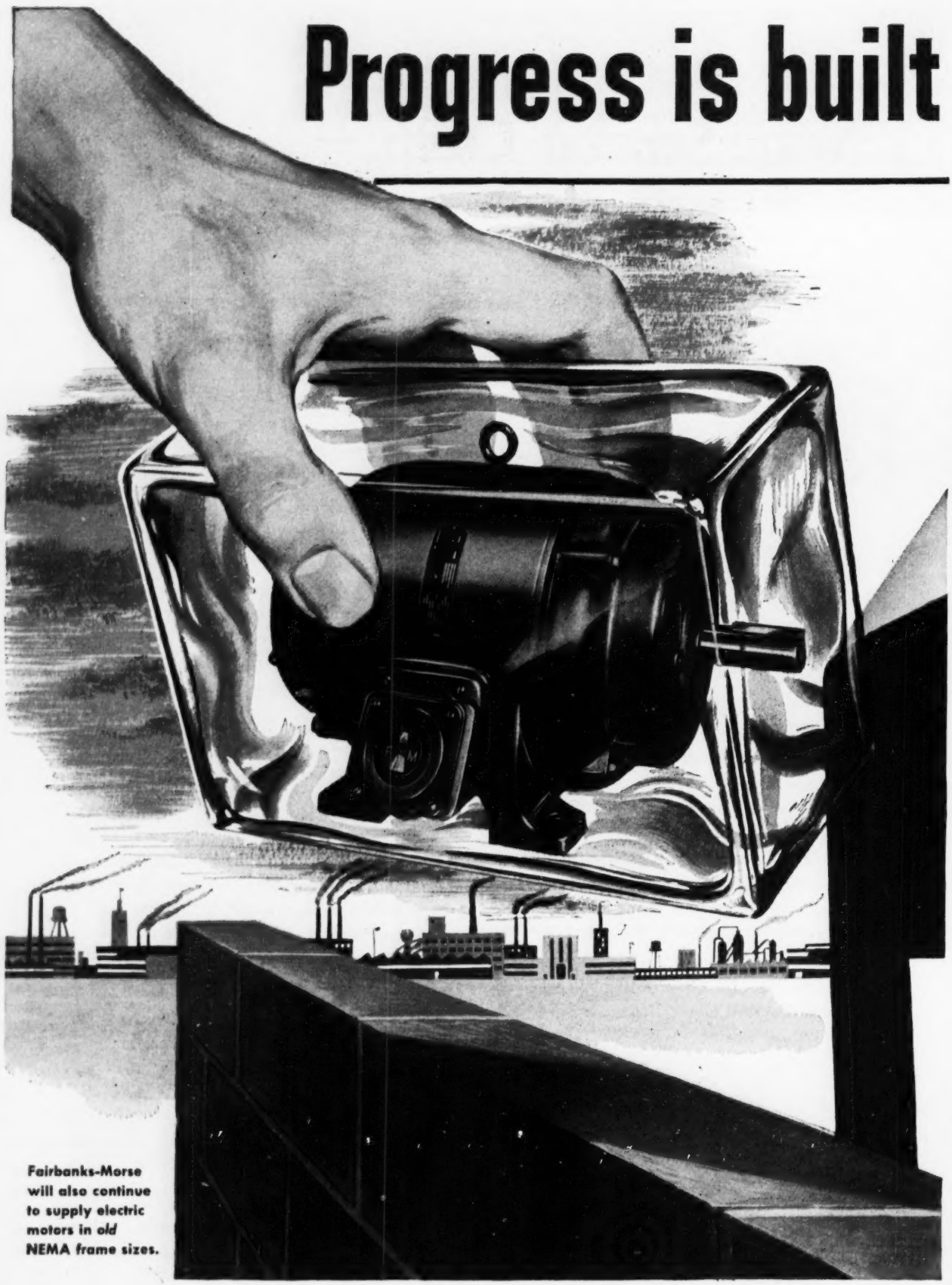
HEWITT (HR) ROBINS

Executive Offices, Stamford, Connecticut

DOMESTIC DIVISIONS: Hewitt Rubber • Robins Conveyors • Robins Engineers • Restfoam

FOREIGN SUBSIDIARIES: Hewitt-Robins (Canada) Ltd., Montreal • Hewitt-Robins Internationale, Paris, France • Robins Conveyors (S. A.) Ltd., Johannesburg • **EXPORT DEPARTMENT:** New York City.

Progress is built



Fairbanks-Morse will also continue to supply electric motors in *old* NEMA frame sizes.

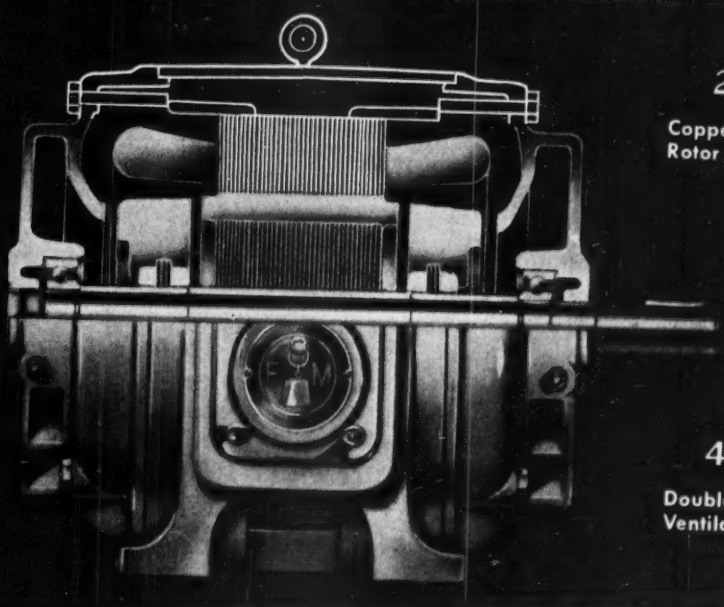
. . . brick by brick

The new NEMA Standard for electric motors is a significant sign of progress to all industry—More Power in Less Space.

But progress—to be lasting—must be built brick by brick For more than a century, Fairbanks-Morse designers have held to the ideal of more performance in less space. They have produced outstanding advancements in the design of diesel engines, pumps, scales, locomotives and the many other products that feature F-M exclusives. Fairbanks-Morse electric motors built on this basic F-M engineering philosophy are continuing assurance of operating economy and efficiency.

Look for the electric motor that stands on this Fairbanks-Morse solid foundation of design progress. It carries the Fairbanks-Morse Seal of Quality.

NEW FAIRBANKS-MORSE GUARDED DRIPPROOF MOTORS



1 Guarded, dripproof construction keeps falling objects and dripping liquids out of motor in any mounting position—maximum motor protection under conditions of wet or dirty operation—indoors or out.

2 Exclusive Fairbanks-Morse feature that provides a virtually indestructible one-piece rotor—homogeneous, free from flaws and gas inclusion for maximum strength and lifetime service.

3 Oversized, precision ball bearings in spacious housings, sealed against grease leakage. Contain ample lubrication for extended periods of rugged service. Convenient flushing and re-lubricating available if desired.

4 F-M exclusive design eliminates hot spots. Cooling outside air is drawn into motor through openings in lower portion of both bearing arms and circulated through cored passages in the frame.

5 New, gasketed, cast iron conduit box permits easy pulling of cables without insulation damage. Fairbanks-Morse exclusive: recess feature allows elimination of conduit box where space is limited.

FAIRBANKS-MORSE
a name worth remembering when you want the best

ELECTRIC MOTORS AND GENERATORS • DIESEL LOCOMOTIVES AND ENGINES • PUMPS • SCALES • RAIL CARS • HOME WATER SERVICE EQUIPMENT • FARM MACHINERY • MAGNETOS

CHECK THE FACTS...

ON NATIONAL CARBON'S FULL LINE OF "KARBATE" PIPE AND FITTINGS FOR CORROSIVE SERVICES

IF YOU NOW USE "Karbate" pipe and fittings, you know their many advantages:

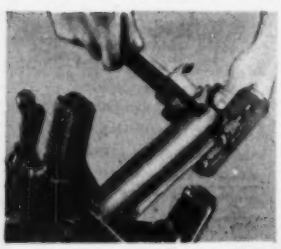
Excellent Corrosion Resistance
Freedom from Metallic Contamination
High Resistance to Thermal Shock
Light Weight
Easy Machining and Fabrication

If you're not familiar with this material, get the facts . . . give them careful consideration when planning layouts where "Karbate" impervious graphite's remarkable combination of properties is required for efficient, trouble-free operation.

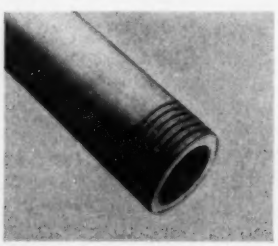
"Karbate" pipe and fittings feature standard stock items in a wide range of sizes . . . designed to make their *proper application* both simple and economical.

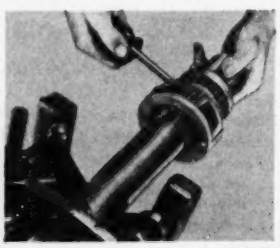
EFFICIENT HAND TOOLS CUT FIELD ASSEMBLY COST

The light-weight hand tools shown below, developed specifically for threading and serrating "Karbate" pipe, contribute to ease and economy of field-fabrication . . . pay for themselves on the first sizeable job. Another reason to check – and *choose* "Karbate" impervious graphite equipment!

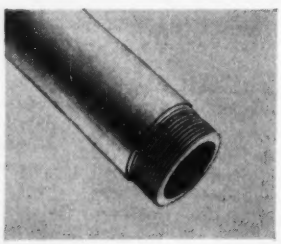


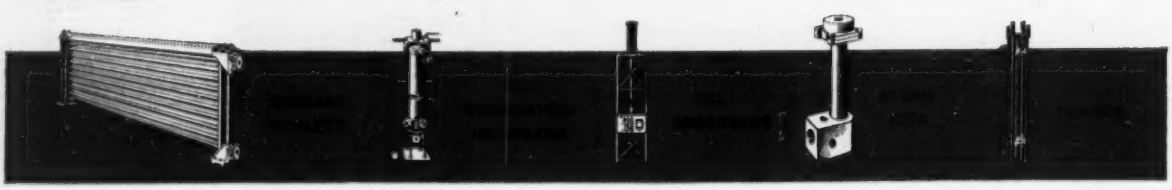
SERRATING





THREADING

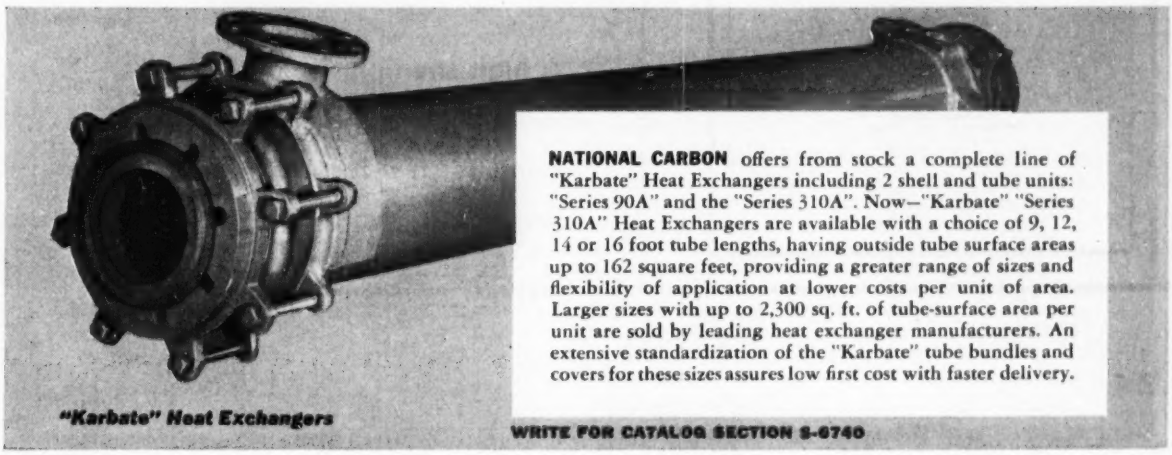




...CHOOSE "KARBATE"

BRAND

IMPERVIOUS GRAPHITE PROCESS EQUIPMENT



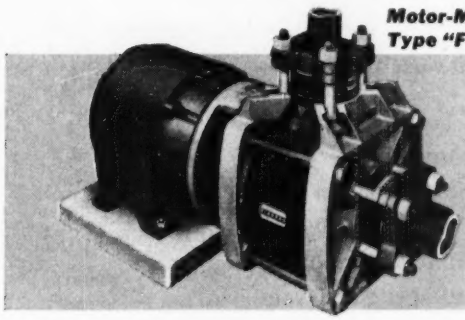
"Karbate" Heat Exchangers

NATIONAL CARBON offers from stock a complete line of "Karbate" Heat Exchangers including 2 shell and tube units: "Series 90A" and the "Series 310A". Now—"Karbate" "Series 310A" Heat Exchangers are available with a choice of 9, 12, 14 or 16 foot tube lengths, having outside tube surface areas up to 162 square feet, providing a greater range of sizes and flexibility of application at lower costs per unit of area. Larger sizes with up to 2,300 sq. ft. of tube-surface area per unit are sold by leading heat exchanger manufacturers. An extensive standardization of the "Karbate" tube bundles and covers for these sizes assures low first cost with faster delivery.

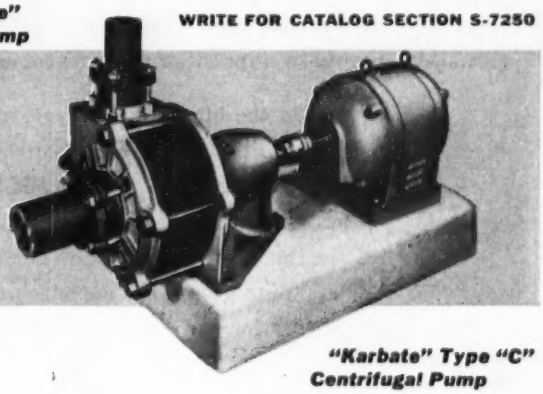
WRITE FOR CATALOG SECTION S-6740

FEATURING improved designs in a broad range of capacities, "Karbate" pumps are your best buy for the widest span of corrosive fluids, including even mildly corrosive services. Ruggedly built, these new pumps are meeting the toughest requirements, virtually eliminating pump down-time.

Motor-Mounted "Karbate" Type "F" Centrifugal Pump



WRITE FOR CATALOG SECTION S-7250



"Karbate" Type "C" Centrifugal Pump

The term "Karbate" is a registered trade-mark of Union Carbide and Carbon Corporation

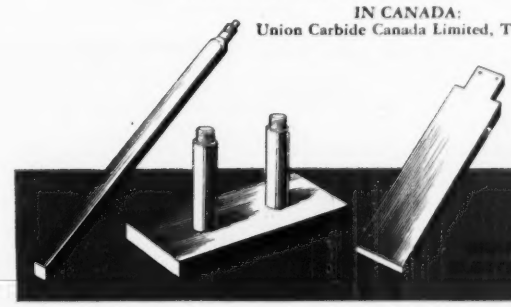
NATIONAL CARBON COMPANY

A Division of Union Carbide and Carbon Corporation

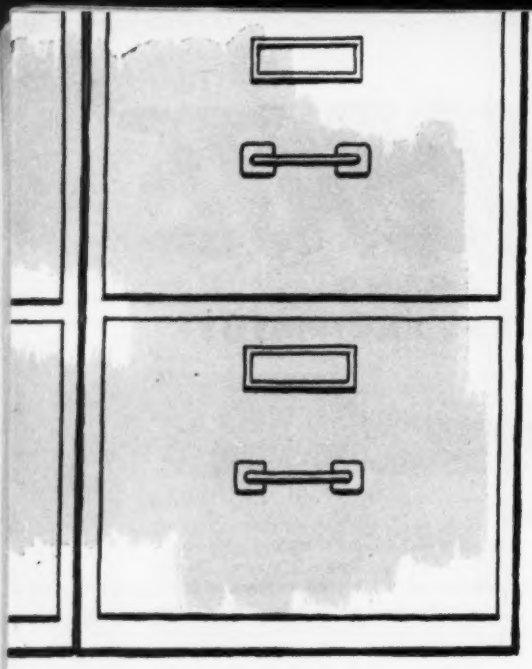
30 East 42nd Street, New York 17, N. Y.

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

IN CANADA:
Union Carbide Canada Limited, Toronto



IMPERVIOUS GRAPHITE
KARBATE
PROCESS EQUIPMENT
NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation.



FILE this list of licensed

A high strength, austenitic stainless steel for severe corrosive service

The type "20" alloy was developed more than fifteen years ago to meet the need for a stainless material with superior corrosion resistance, particularly to sulfuric acid.

Through the years thousands of tons of the "20" alloy have been produced largely for the chemical industry in the form of valves, pumps, pipe, tubing, heat exchangers, and tanks. In fact, there is no limit to the types of equipment that can be made in this versatile alloy.

On the opposite page you will find a list of licensed producers. In the United States, The Carpenter Steel Company is the exclusive producer of bar, sheet, plate, strip and tubing. Atlas Steels Limited produces sheet and bar in Canada. There are twenty producers of castings in the United States and Canada. We feel that this is an outstanding group of companies, any of whom can ably fulfill your requirements for the items they produce.

The Duriron Company, Inc.
Licensor

producers of the proven type "20" alloy

Alloy Steel Products Company Linden, New Jersey	Aloyco-20	For own products
Atlas Steels Limited Welland, Ontario, Canada	Atlas Stainless 20	Bar, Sheet and Plate
The Carpenter Steel Company Reading, Pa.† and Union, N. J.*	Carpenter Stainless No. 20 and No. 20-Cb.	†Bar, Strip, Wire *Tubing, Sheet, Plate
The Cooper Alloy Foundry Company Hillside, New Jersey	Cooper Alloy FA-20	Castings and for own products
Crane Co. Chicago, Ill.	Craneloy-20	For own products
The Duriron Company, Inc. Dayton, Ohio	Durimet 20	Castings and for own products
Electric Steel Foundry Company Portland, Oregon	Esco Alloy 20	Castings
Empire Steel Castings, Inc. Reading, Pa.	Isocast 20	Castings
General Alloys Company Boston, Mass.	Q-85	Castings
Hanford Foundry Company San Bernardino, Calif.	Hanford 20	Castings
Hayward Tyler of Canada Ltd. Kitchener, Ontario, Canada	Alloy B5	Castings
Lebanon Steel Foundry Lebanon, Pa.	Circle D -34	Castings
Michigan Steel Casting Co. Detroit, Michigan	Misco-20	Castings
The Midvale Company Philadelphia, Pa.	Midvaloy-20	Castings
The Ohio Steel Foundry Company Springfield, Ohio	Fahrite C-20	Castings
Ross-Meehan Foundries Chattanooga, Tenn.	R-M 20	Castings
Shawinigan Chemicals Limited Montreal, Canada	Shawinigan 20	Castings
Sivyer Steel Casting Company Milwaukee, Wisconsin	Sivyer	Castings
Stainless Foundry & Engineering Co. Milwaukee, Wisconsin	S-20	Castings
Utility Steel Foundry Vernon, Calif.	Utiloy 20	Castings
Waukesha Foundry Company Waukesha, Wisconsin	Waukesha 20	Castings
Welland Electric Steel Foundry Ltd. Welland, Ontario, Canada	Welmet 20	Castings

KELLEY

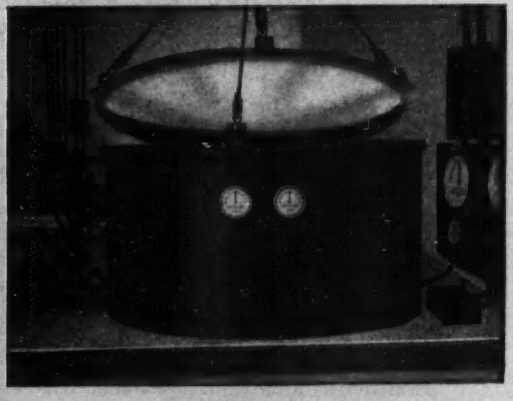
Pioneers in HOMOGENEOUS LEAD BONDING

First Again with a "NEW MECHANICAL"* Bonding Process

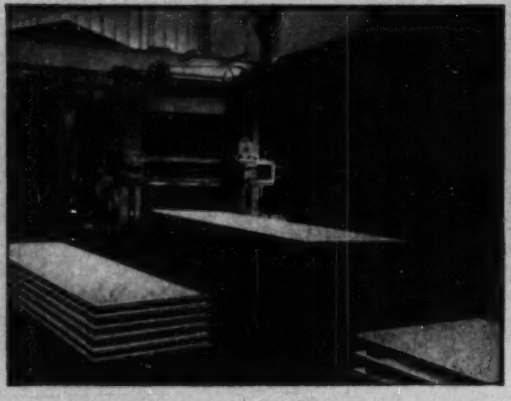
*Our newly developed "mechanical" process for applying **Homogeneous Lead Bondings** affords you a considerable saving in both delivery time and cost over the slower "hand-burning" method.

We suggest that you pay a visit to our plant and view this newly developed "Mechanical" cost-saving lead bonding process. Our Engineers are available for consultation without obligation. Your inquiries are solicited.

Homogeneous Lead Bondings are applied to any thickness of shell plates in the flat before shaping to your specifications. Plates as large as 10'-0" x 20'-0" are easily handled on our new unit, thus eliminating many unnecessary weld seams. Outlets and connections are Homogeneously Bonded regardless of size.



To insure uniform overall thickness of the Homogeneous Lead Bondings and eliminate the human errors occurring in other methods, lead is applied "oversize" to flat sheet plates and then planed to required thickness. In addition, this operation affords considerable savings in time over the general "Hand Scraping" method.



Dished Heads of all types and various irregular shaped pieces of equipment are Homogeneously Lead Bonded in our Special "MECHANICAL" Unit. Here again, considerable saving in time and cost is effected over the general method.

KELLEY Custom-Built for the Processing Industries

TANKS · LEAD COILS · LEAD & LEAD LINED VALVES
SHEET LEAD LININGS · CASTINGS & FITTINGS

STAINLESS STEEL
LEAD
WOOD
STEEL
Fabrication

O. G. KELLEY & CO.

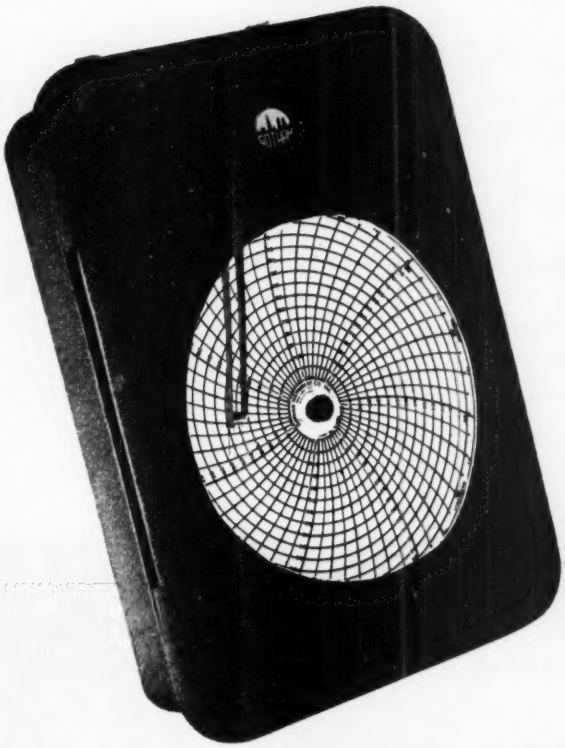
ENGINEERS DESIGNERS FABRICATORS

96 TAYLOR STREET, BOSTON 22, MASS.

CLEVELAND, OHIO · NEW YORK, N.Y. · PITTSBURGH, PA.
JOHNSON CITY, TENN. · HOUSTON, TEXAS · ELIZABETH, N.J.

GOTHAM CONVERTIBLE

grows or changes to fit your needs



Want an instrument that can grow or change to fit your needs—an instrument that is a miser for maintenance and replacement inventory?—Then choose the Gotham Convertible. It is a 1-2-3-4 pen recorder; 14 pressure, temperature and time operation combinations. It is a recorder controller; there are 38 pressure, temperature and time operation combinations.

All components are Gotham standard, factory calibrated systems, completely interchangeable and easily removable or replaceable at the job site.

Number of functions possible depends on whether instrument is 6", 9" or 12" chart size.

GOTHAM INSTRUMENTS

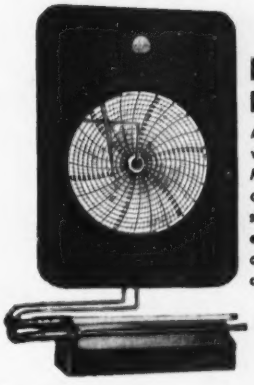
Keep everything under control with Gotham

SELF-CONTAINED PORTABLE RECORDER

Here, at last, is a portable recorder built to full-size instrument reliability. Built from Gotham standard elements, interchangeable with other Gotham instruments. 6", 9" and 12" chart sizes. Mercury, Vapor or Pressure Actuated. Spring or electric chart drive. See Catalog 400.

RECORDING PSYCHROMETER

Incorporates highly accurate and responsive thermal systems and many other Gotham standard convertible elements. Wet and dry bulb type. Motor-driven suction fan. 12" chart size. Catalog 400.



RECORDING HYGROMETER

A 2-pen recorder of the wet and dry bulb type. Mercury or Vapor Actuated. 9" and 12" chart sizes. Available with variety of wet and dry bulb assemblies depending on application. Catalog 400.

GOTHAM INSTRUMENTS
Division of American Machine and Metals, Inc.
Dept. 2, 233 Broadway
New York 12, New York

Please send me a copy of your

- ☐ Catalog 100—Industrial Thermometers
- ☐ Catalog 200—Dial Type Thermometers
- ☐ Catalog 400—Recorders, Psychrometers, Hygrometers
- ☐ Catalog 500—Controllers
- ☐ Have your representative call. No obligation.

Name.....Title.....

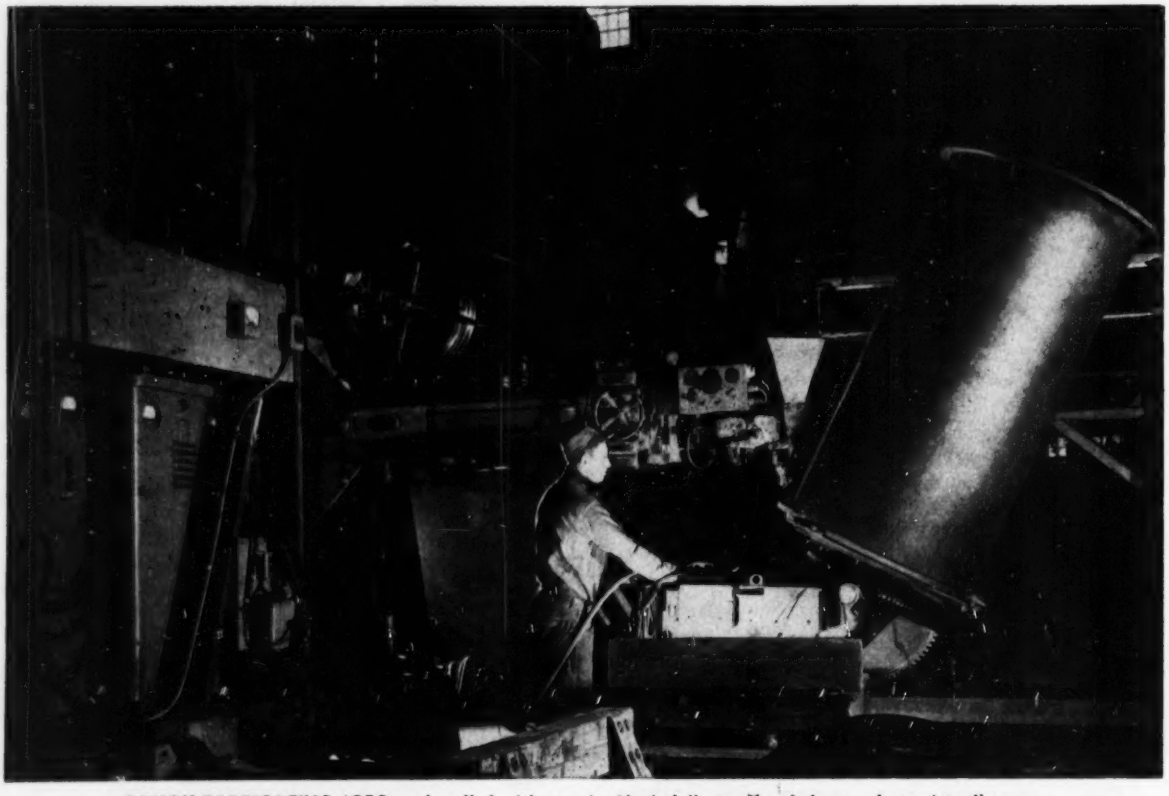
Company.....

Address.....

City.....Zone.....State.....

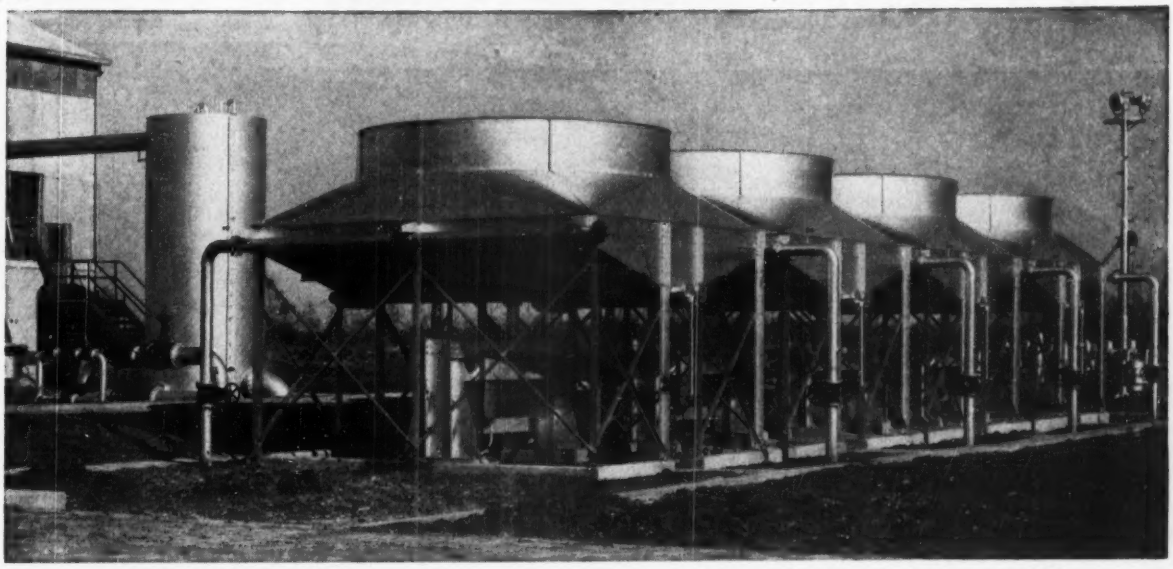
Profit-building answers to Modern

. . . examples of the wide variety of equipment designed and built by Alco to meet today's demands in petroleum and petrochemical processing . . . results of **Alco Experience** . . . gained through many years of designing and building equipment for refining and processing companies the world over . . . and **Alco Facilities** . . . capable of handling economically an extremely wide range of metal-fabricating operations . . . of meeting strictest customer requirements.

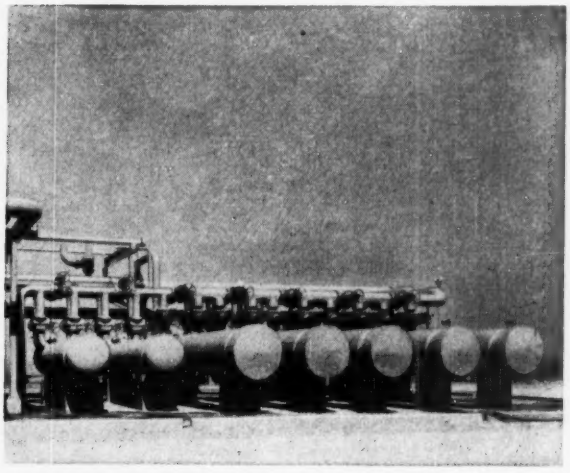


TOUGH FABRICATING JOBS are handled with ease in Alco's fully equipped shops, where virtually any type of equipment can be built at realistic low cost. Here a section of steel pipe, mounted on a universal-position pedestal, has flanges attached by submerged arc welding.

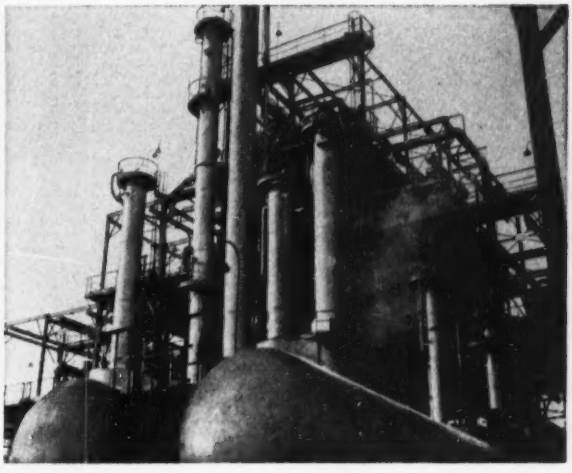
Processing problems



JACKET WATER COOLING for compressor engines on cross-country pipeline is efficiently performed by Alco Aircoolers even during summer's high ambient temperatures. Available in radiator-core and fin-tube types, Alco Aircoolers offer lower costs in scores of applications.



ALCO GAS COOLERS serve two absorption towers working in parallel at Lion Oil Company's Diamond M-Sharon Ridge gasoline plant near Snyder, Texas. Geared to produce 375,000 gal of petroleum products per day, Diamond M uses 39 Alco shell-and-tube heat exchangers of 21 separate types.



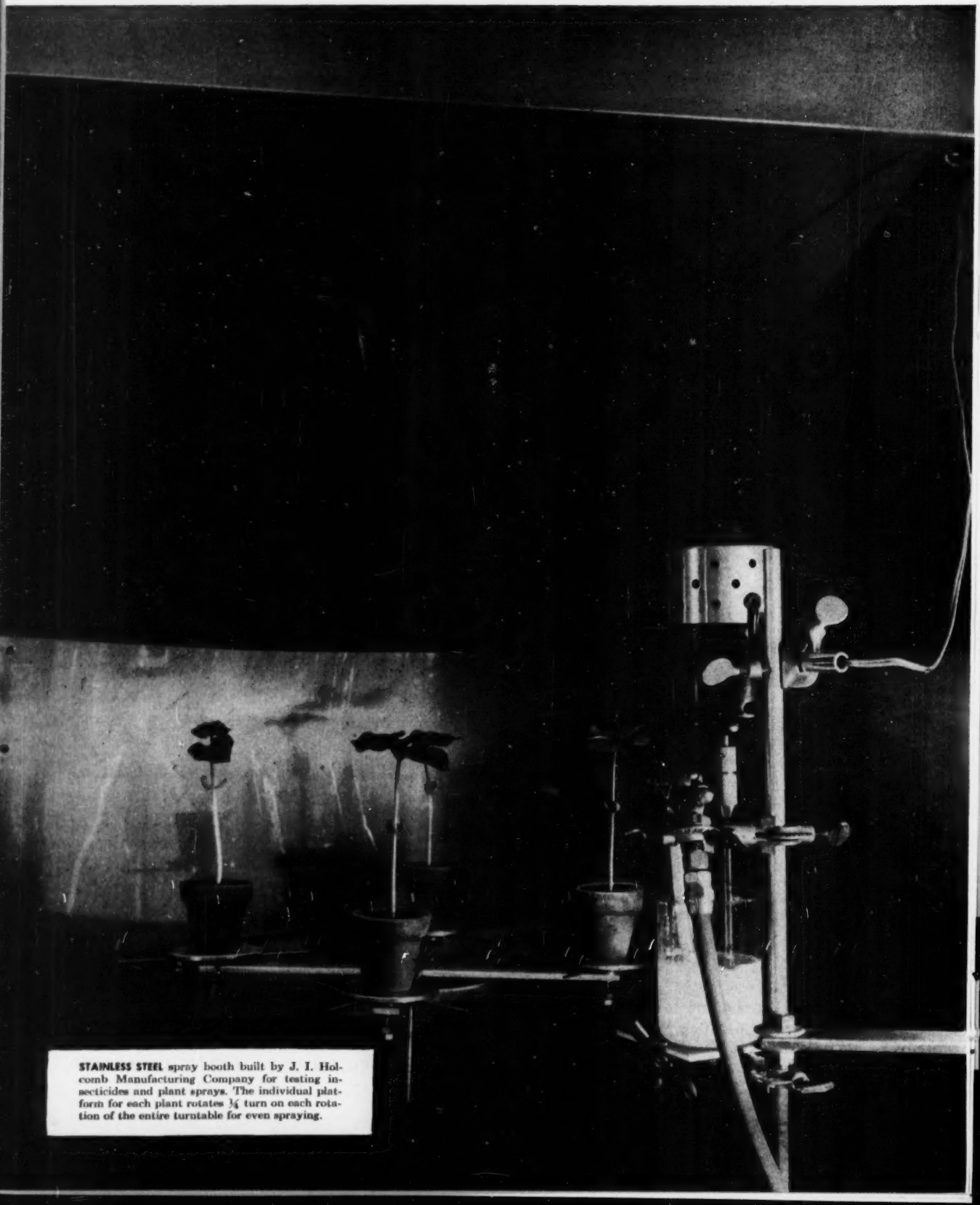
GRANGEMOUTH, SCOTLAND, is one of the world's oldest petroleum refining centers, with shale oil processing dating back over 100 years. At this historic site, Anglo-Iranian's refinery included 18 types of Alco heat-exchange equipment in its extensive expansion and modernization program.

How about your processing problems? Is heavy-duty service a factor? If so, contact your nearest Alco sales representative today —as the first step toward profit-building answers for you.

ALCO
PRODUCTS
AMERICAN LOCOMOTIVE COMPANY
Sales and Service Offices in Principal Cities

IN THE LABORATORY...

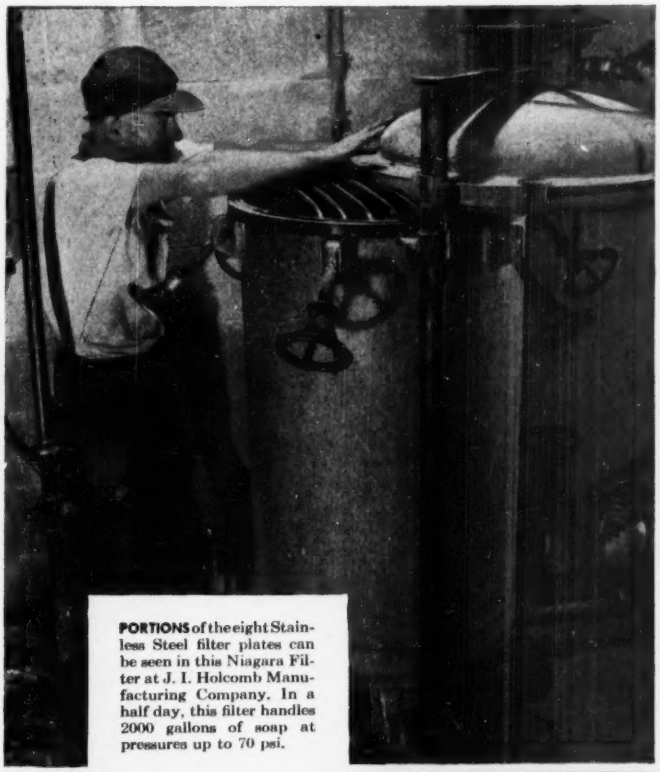
J. I. Holcomb takes advantage of Stainless



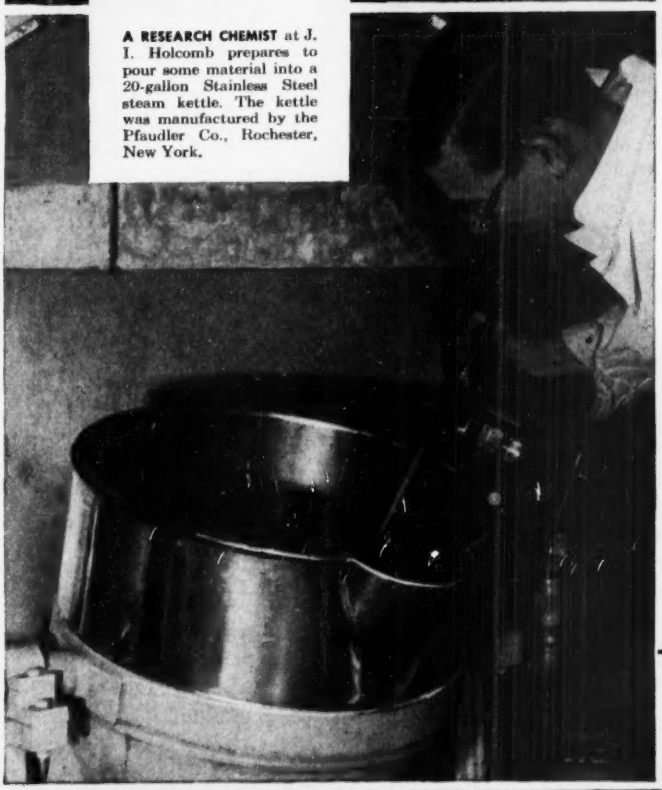
STAINLESS STEEL spray booth built by J. I. Holcomb Manufacturing Company for testing insecticides and plant sprays. The individual platform for each plant rotates ¼ turn on each rotation of the entire turntable for even spraying.

IN MANUFACTURING OPERATIONS . . .

Steel's corrosion resistance and cleanliness



PORTIONS of the eight Stainless Steel filter plates can be seen in this Niagara Filter at J. I. Holcomb Manufacturing Company. In a half day, this filter handles 2000 gallons of soap at pressures up to 70 psi.



A RESEARCH CHEMIST at J. I. Holcomb prepares to pour some material into a 20-gallon Stainless Steel steam kettle. The kettle was manufactured by the Pfaudler Co., Rochester, New York.

Manufacturing a variety of cleansers, waxes, soaps, sprays and insecticides for industrial, commercial and institutional uses, J. I. Holcomb Manufacturing Company, Indianapolis, Ind., must meet the specialized and critical nature of its markets with high standards of quality.

As a result, the firm makes full use of Stainless Steel, both in the laboratory where many of the products are developed and in their manufacturing operations.

A special spray booth for testing all kinds of insecticides and plant sprays has been constructed entirely of Stainless Steel. Booths made of wood tend to carry over traces of one spray test into the next. Ordinary metals cause difficulty because of the corrosive natures of both the insecticides and the cleaning solvents. But Stainless Steel's gleaming surface can be kept clean easily with the use of solvents.

A 20-gallon Stainless Steel test kettle has been in use for about one and one-half years handling all types of formulations and organic reactions. Probably its most severe test was encountered when ferric chloride was employed as an oxidizing agent in converting one organic chemical to another at 100°C. The reaction was completed satisfactorily and the kettle came through unscathed.

In manufacturing operations, a filter lined with Stainless Steel has been in service eight years. It handles four different soaps manufactured for industrial and institutional uses, filters out unsaponifiable materials to clear the mixtures.

You, too, will find, like this satisfied company, that Stainless Steel equipment can eliminate many problems of corrosion and cleanliness, both in the laboratory and in production operations. And when you order Stainless equipment, be sure the fabricator uses perfected, service-tested USS Stainless Steel.

UNITED STATES STEEL CORPORATION, PITTSBURGH
AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

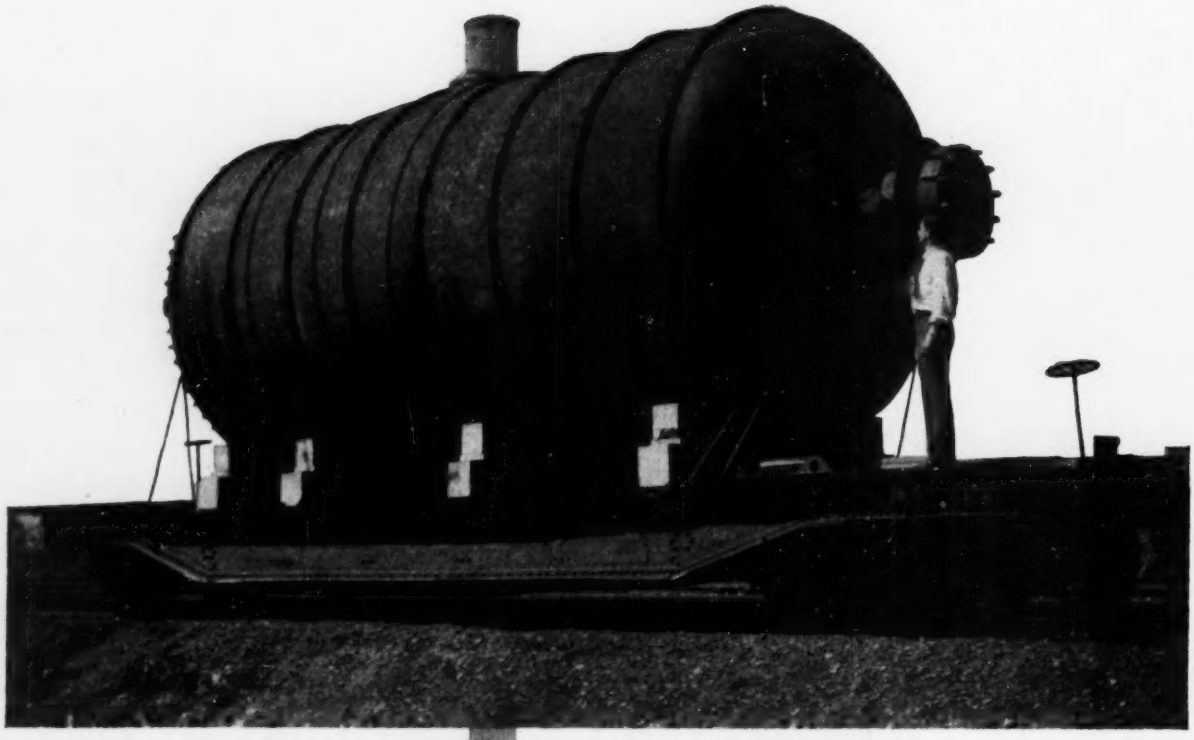
USS STAINLESS STEEL

SHEETS · STRIP · PLATES · TUBES · WIRE — USS — BARS · BILLETS · PIPE · SPECIAL SECTIONS

4-1020

UNITED STATES STEEL

LINTERS....STEAM....



One of six rotating digesters designed and built by B & W for the Buckeye Cotton Oil Company. Dimensions: 31 ft 3 in. long, 11 ft I.D. Working pressure: 165 psi. Temperature: 350 F. Material: Shells, heads and cones to ASME Spec., SA-212 Grade A, 65,000 tensile strength steel.

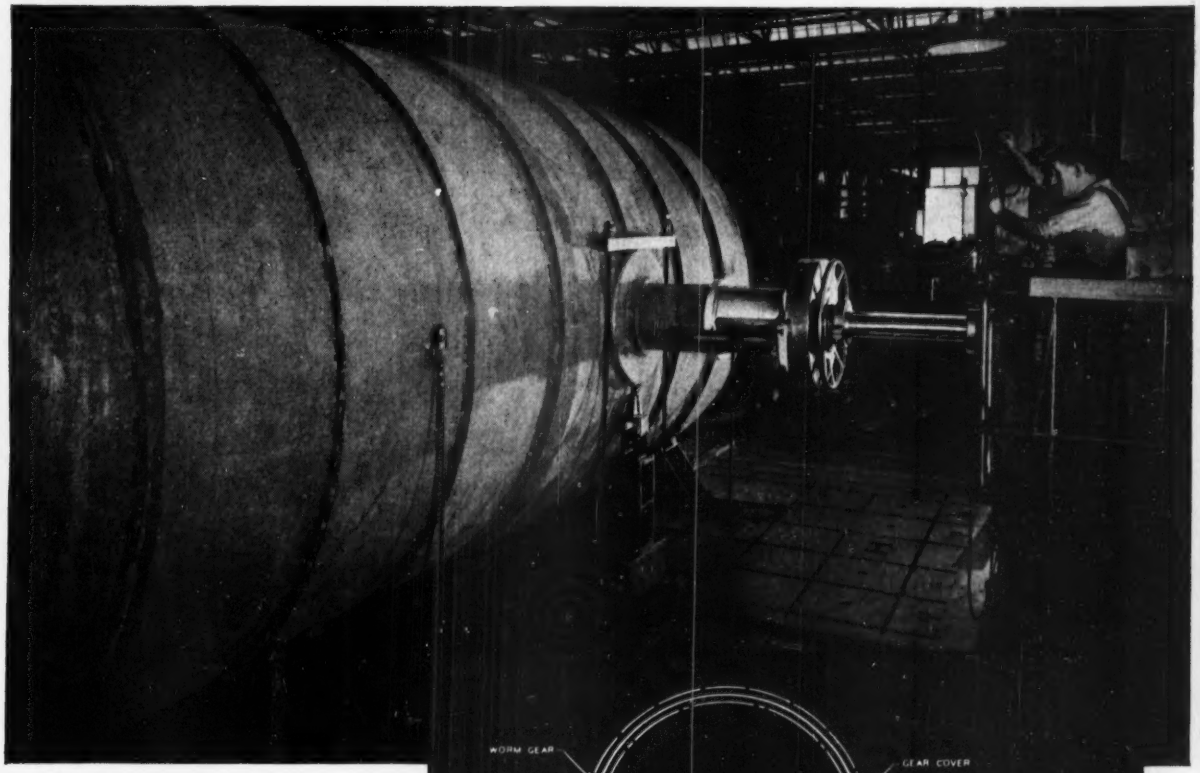
Starting with cotton seed linters, Buckeye Cotton Oil Company makes pulp which eventually becomes rayons and plastics. The linters, with steam and a caustic solution, are cooked in large digesters. (Buckeye, a Procter & Gamble subsidiary, is located at Memphis, Tenn.).

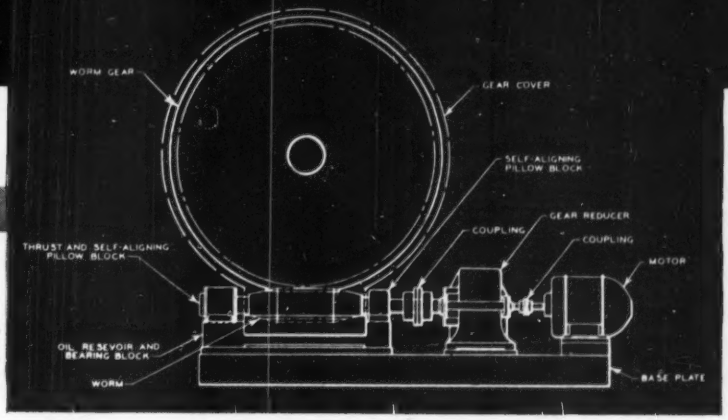
Regarding the trunnions, they are important. They enable the digester to rotate end over end in either direction—one revolution in four minutes. Result: Better mixing and a high quality pulp.

This equipment was designed, fabricated, and installed by B&W . . . and is typical of many other projects where B&W has successfully relieved plant engineers of tough engineering problems. The Babcock & Wilcox Company, Process Equipment Dept., Barberton, Ohio.

COOK...TRUNNIONS...

Each digester rotates end over end on two separate forged steel trunnions of 16 in. diameter, welded onto a heavy steel girth band around the center section of the vessel. This B&W trunnion design is markedly superior to conventional through-shaft construction because it distributes weight-stresses over a large area of the shell, greatly increasing corrosion-resistance at these critical points. Trunnions are supported by two heavy water-cooled bearings.





Individual drive mechanisms for the digesters also were engineered and built by B&W to assure satisfactory operating conditions, with a maximum torque load of 540,900 ft-lb and an end thrust of 118,000 lb created by shifting center of gravity when digester is partially filled. Provision for either-direction rotation simplifies vertical positioning of digester for connecting to blow line.

BABCOCK & WILCOX

5-416

Constant control of quality

Quality control is a continuous job. It is carried out with modern equipment and painstaking attention to detail in every phase of the production of Nialk chemicals.

for example...

NIALK CAUSTIC POTASH: The controlled quality and uniformity of NIALK Caustic Potash and NIALK Carbonate of Potash contribute importantly to the satisfactory performance of many highly sensitive photographic baths.

Every step in the production of these NIALK products is rigidly controlled to give absolute satisfaction in many types of applications.

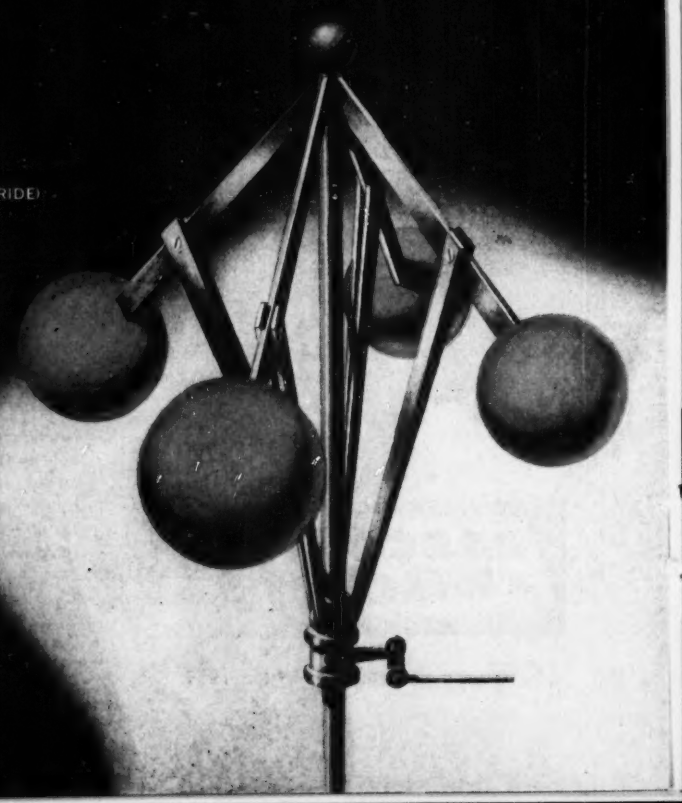
NIAGARA ALKALI COMPANY

60 East 42nd Street, New York 17, New York

Nialk®

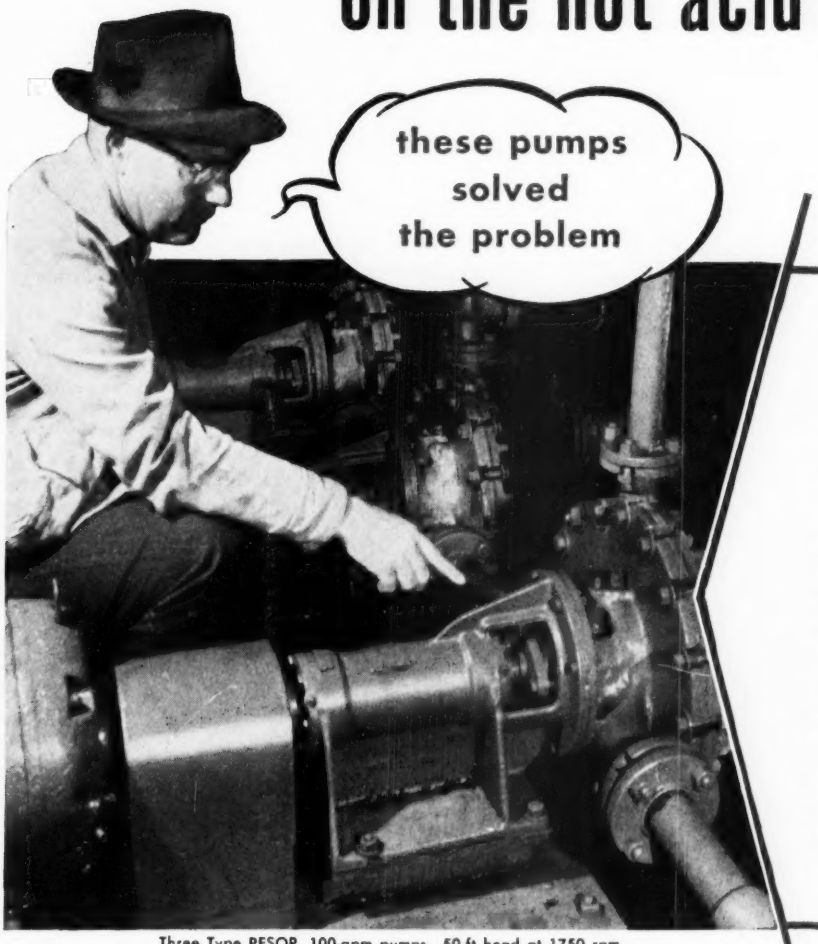
- LIQUID CHLORINE
- CAUSTIC POTASH
- CARBONATE OF POTASH
- PARADICHLOROBENZENE
- CAUSTIC SODA
- TRICHLORethylene

NIAGATHAL (TETRACHLORO PHTHALIC ANHYDRIDE)



No More Leakage

on the hot acid line...



Three Type PESOR, 100-gpm pumps. 50-ft head at 1750 rpm.

Why this A-C pump does not leak

These process pumps have *Equiseal* stuffing box. This is an auxiliary impeller which produces a low pressure area in front of the packing. This low pressure area prevents the liquid from entering the packing. Equipped with an *Equiseal* stuffing box, an A-C pump will actually run without packing and not leak. Pumps also are available with standard stuffing box or mechanical seal. Each application is individually engineered.

Allis-Chalmers process pumps are available in a wide choice of materials to handle many types of abrasive or corrosive material at temperatures up to 250 F.

Tennessee Products and Chemical Corp., Chattanooga, Tenn., solved a tough pumping problem with Allis-Chalmers process pumps. Previous pumps used for sulphate recovery leaked badly. They were a constant source of packing and mechanical seal trouble. In addition, the leaking chemical shortened the life of the surrounding equipment. Production of the entire recovery system depends on these pumps. Every stop lowers production... boosts costs.

Then Allis-Chalmers process pumps were installed. They pump hot acid with ammonium sulphate (sand sized particles) 24 hours a day, 7 days a week. There is no leakage... packing and seal trouble is gone... maintenance costs are cut sharply.

For full information on Allis-Chalmers pumps and how they can help you with your pumping problems, call your local A-C representative, or write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 08B6615.

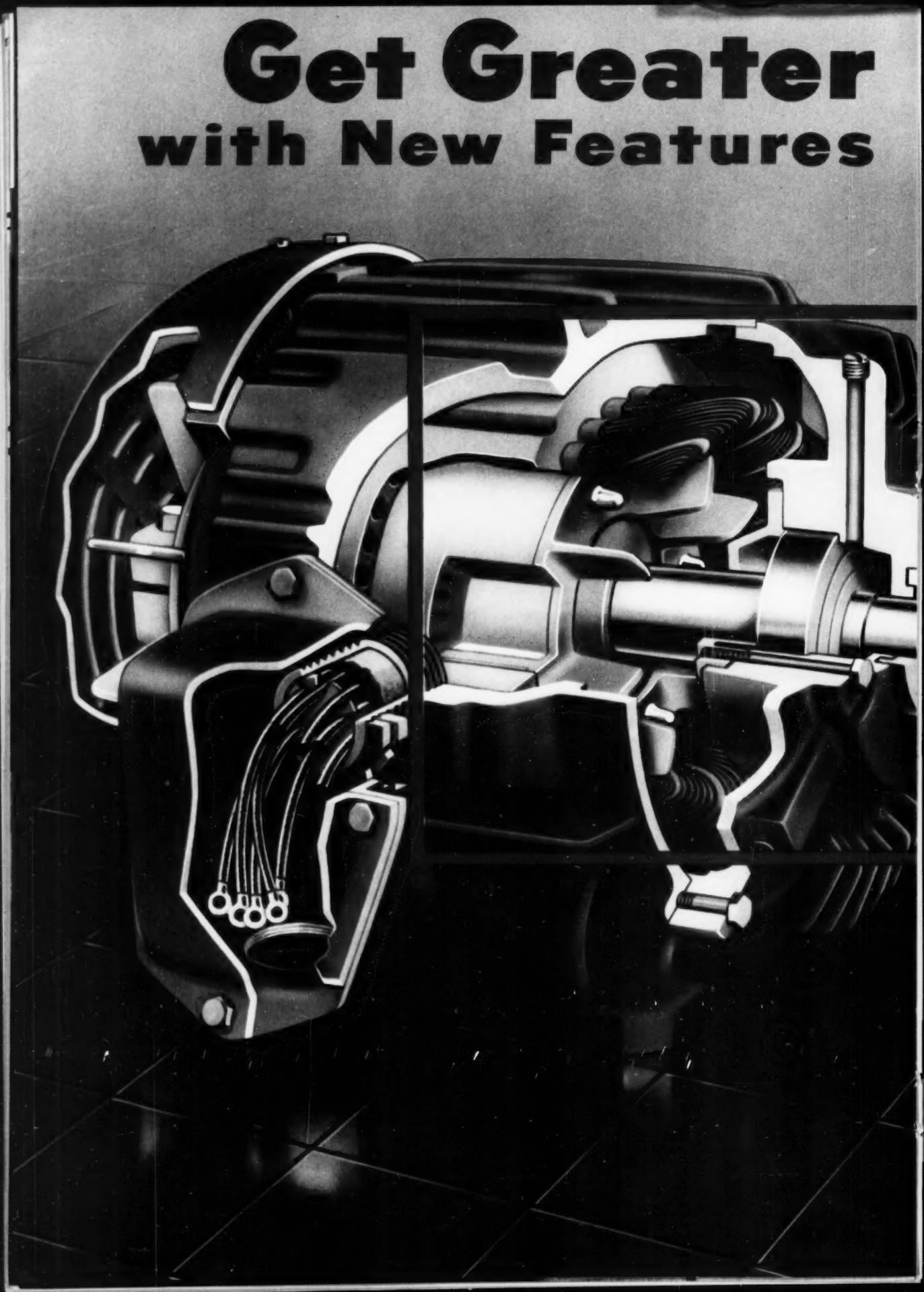
A-4230

Equiseal is an Allis-Chalmers trademark.

ALLIS-CHALMERS

A-C ALLIS CHALMERS

Get Greater
with New Features

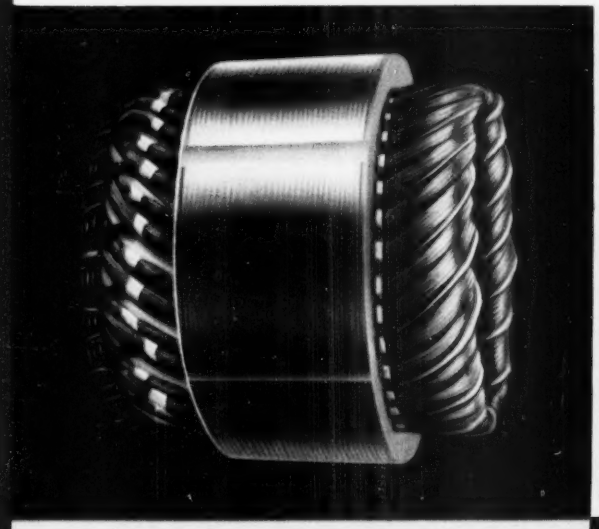


Motor Economy
. . . Proved Principles

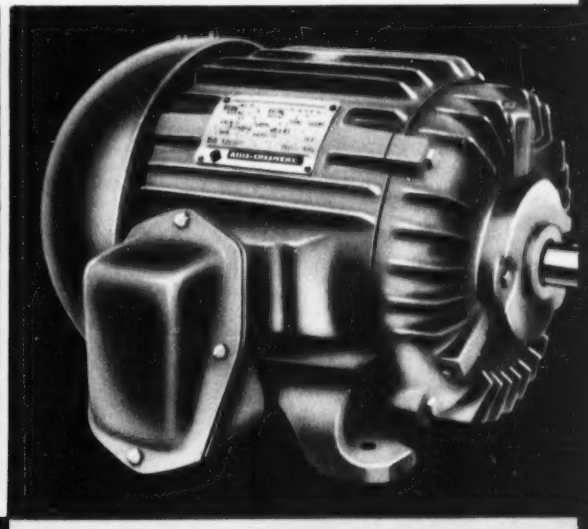
Here's the inside story of a great new motor. It combines the best of the new developments in methods and materials with the best of the tried and proved principles that have made such an outstanding record for Allis-Chalmers motors.

Smaller in size than previous design, it retains the easy-to-clean, fin-type construction which Allis-Chalmers pioneered several years ago. The bearing design gives greater bearing protection, ease of maintenance and long life. Insulation gives you famous Allis-Chalmers rugged dependability.

Consult your nearby Allis-Chalmers Authorized Distributor or District Office on your motor needs. Or write for Bulletin 51B6210.



STATOR DOUBLE INSULATED —Stator laminations are welded across back for rigidity. Heavy varnished cambric insulation is inserted between phase windings. Wound stator is dipped several times in special insulating varnish of proved effectiveness and stamina, and baked after each dip. The Allis-Chalmers stator is both physically and electrically strong . . . thoroughly protected against moisture, heat and corrosion.



FIN-TYPE CAST-IRON FRAME — Proved by years of service. Cooling ribs are cast integrally with the yoke; air is blown over them without restriction. There are no enclosed external air passages to clog up with dirt and thereby ruin cooling efficiency. Radiating surface provides reserve cooling capacity for extra strenuous duty. Cleaning, if required, is a few moments work with an air hose, brush or vacuum cleaner.

Multiple bearing protection keeps grease in... keeps dirt out...permits relubrication in service

Extreme care has been taken to provide longest possible bearing life and lowest possible maintenance costs. The bearing itself is of double-shielded type, which allows controlled migration of grease in and out of the bearing to suit operating conditions. Yet bearing is protected against greatest cause of bearing trouble — overgreasing.

Close running clearances and double labyrinth seals between the shaft and outer bearing housings keep grease in the bearing and exclude dirt. Grease is kept out of the interior of the motor by a bearing cap with a long running clearance along the shaft. The cap is held tightly in place by hex head cap screws. Large grease chambers hold an ample supply of lubricant.

A-4363

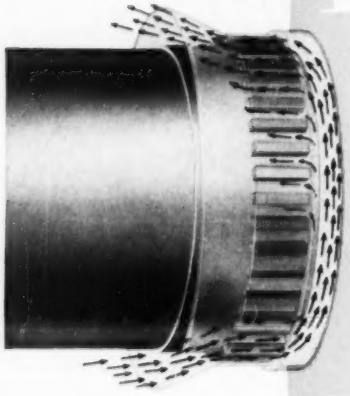
ALLIS-CHALMERS

MILWAUKEE 1, WISCONSIN

Two Ways

You Can Reduce Operating Costs on Rotary Kilns...

Install an Air-Cooled Kiln End



No improvement you can make can cut your costs so much! Operating records show that an Air-Cooled discharge end will *pay for itself in 2 to 3 years* in refractory savings alone.

An Air-Cooled end circulates cooling air around the outside of discharge end and on underside of nose brick. Your kiln end stays cool, round and rigid — no warpage or end distortion.

You eliminate shutdowns required to replace end brick . . . gain valuable production time. Big fuel savings too — because Air-Cooled kiln end permits the use of a positive seal between firing hood and kiln.

. . . and an Air-Quenching Cooler

Save on fuel costs! Save on installation costs! Save on power, maintenance and clinker grinding costs!

Air-Quenching cooler captures hottest air from cooling clinker at feed end. Movable baffle in the housing directs this hot secondary air directly to kiln. Clinker is cooled by a direct up-blast of cooling air. Fuel costs are sharply reduced.

Be sure to get your copy of new cooler bulletin, 07B7869. It shows how to figure how much an Air-Quenching cooler will save for you. Get it from the A-C representative in your area or write Allis-Chalmers, Milwaukee 1, Wisconsin.

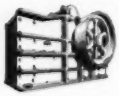
A-4381

ALLIS-CHALMERS A-C ALLIS-CHALMERS

Sales Offices in Principal Cities in the U. S. A. Distributors Throughout the World.

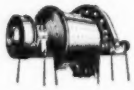
Kilns, Coolers, Dryers

Hammermills



Jaw Crushers

Gyratory Crushers



Grinding Mills

Vibrating Screens

FINANCIAL AID TO HIGHER EDUCATION

Our Colleges and Universities Face Grave Financial Problems

For the past decade the nation's colleges and universities have been caught in a destructive financial squeeze. It is particularly destructive for the independent, privately endowed institutions. Unless extraordinary measures are taken to relieve this squeeze, it promises to become progressively worse. To let it do that is to court a national disaster.

This is the first of two editorials devoted to the financial plight of our colleges and universities. This first editorial deals with the character of the problem, present and potential. The second will indicate some things that need to be done about it, and particularly what American business might do.

Enrollment Soars, Income Lags

In broad outline, the financial problem that afflicts our colleges and universities is simple. The demand for their services has increased rapidly, and promises to keep on increasing even more rapidly. At the same time, their financial capacity to provide these services has lagged behind, primarily because of price inflation.

Between 1940 and 1950, college and university enrollment increased from approximately 1⅓ million to 2⅓ million—about 75 per cent. Over the same period, the educational income of these institutions, measured in terms of its actual purchasing power, increased only about 64 per cent. Thus, at the end of the decade, our colleges and universities as a group had, on the average, about 6 per cent less to spend per student than they had at the beginning. Meanwhile, the rapid advance of science and technology had made a good college or university course a much more expensive operation than it was in 1940. Since 1950, the latest date for which comprehensive figures are available, the financial squeeze on our colleges and universities has intensified, largely because of another wave of price inflation touched off by the Korean War.

Among the colleges and universities, the independent, privately endowed institutions are particularly hard pressed. In terms of actual purchasing power, the independent liberal arts colleges are now spending at least 20 per cent less per student than they spent in 1940. Public institutions of higher learning, supported out of tax revenues, have managed to increase slightly their expenditure per student. Otherwise, the financial squeeze on higher education as a whole would be even more severe.

Why Independent Colleges Are Hit Hardest

The principal reason why the independent colleges and universities are so hard up is the shrinkage in their income from endowments. These endowments, created in other days by gifts of generous benefactors to help pay the expenses of higher education, have been hit hard from two directions. During the war and post-war years, the tax collector took so large a part of the incomes and estates of wealthy people that this source of endowments has been greatly reduced. Over the same period price inflation cut in half the purchasing power of the income derived from existing endowments. In 1940 income from endowments provided 26 per cent of the total income of the independent colleges and universities. By 1950 it provided only 14 per cent. The figure is still lower today.

The financial plight of the independent colleges and universities is directly reflected in the salary status of their teaching staffs. In mid-1952 a national survey showed that, after adjustment for the increased cost of living, the salaries of those holding full professorial rank in these institutions were 12 per cent lower than they were in 1941-42. Junior teachers, with the rank of instructor, fared somewhat better. In terms of actual purchasing power, their salaries declined only 2 per cent over the 12-year period, largely because there is more direct competition for their services from industry. Over the same period, the real wages of industrial workers increased 55 per cent.

Time Will Not Provide a Cure

The plight of the colleges and universities, which is shared in some degree by all parts of our educational system, is not one that can be left to time for a cure. On the contrary, the financial problems of our institutions of higher learning will be intensified in the years ahead by the pressure of rapidly increasing enrollments. Present prospects indicate that during the next decade college and university enrollment will increase by about one-third, or from 2⅓ million to over 3 million. The problem of increased enrollments will become particularly acute toward the end of this decade when the babies born during the great surge of population in World War II are ready to enter college.

Such an increase in population as that now in prospect can be a tremendous asset to the nation. It is still a truth, even though it is worn a bit thin by frequent repetition at commencement exercises, that a nation has no resource more valuable than the education of its people. And the better the education, the more valuable the asset.

But to realize this, our colleges and universities must have the financial strength to handle the increased enrollments that face them in the years ahead. This means that we must relieve our independent colleges and universities, in particular, from the financial squeeze in which they are now caught and make them full partners in the economic well-being of the nation. Some of the means by which American business might help achieve this will be discussed in a second editorial.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

Remember the trade marks "tt" and "TUBE-TURN" are applicable only to products of TUBE TURNS.

tt TUBE-TURN TRADE MARKS

the complete line FOR ALL YOUR NEEDS

YOU CAN specify TUBE-TURN Welding Fittings and Flanges and know that you will get the *exact* answer to your specific piping problem. This leading line includes more than 4,000 items, in all piping materials . . . carbon steels, non-ferrous metals and alloys . . . schedules and sizes to match *your* design.

Carbon steel elbows, for example, are available from ½" to 42" diameter. Your nearby Tube Turns' Distributor provides this *complete* line promptly and backs it up with the thorough Engineering Service and how-to-do-it information of Tube Turns.

The Leading Manufacturer of Welding Fittings and Flanges

TUBE TURNS LOUISVILLE 1, KENTUCKY

A Division of National Cylinder Gas Company

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Cleveland • Toledo • Chicago • Denver • Los Angeles San Francisco • Seattle • Atlanta • Tulsa • Houston • Dallas • Midland, Texas

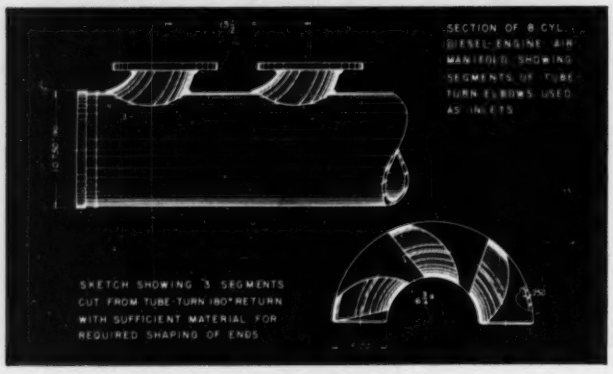
ENGINEERING SERVICE

Here's *Service* to help you solve your piping problems

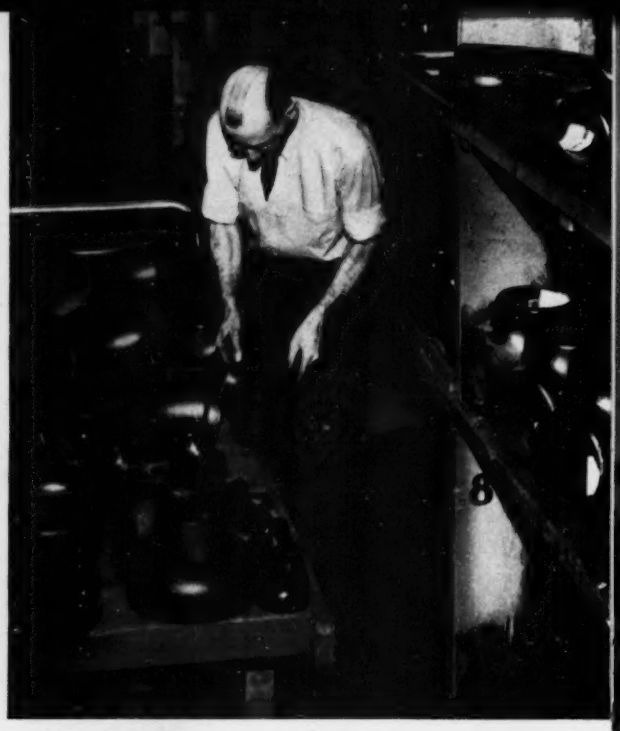
TUBE TURNS' Engineering Service Division makes available a vast fund of experience for the solving of design and operating problems in piping. For example:

An engine builder was fabricating manifolds from formed plate. Poor fitup was a problem and costs were excessive. Tube Turns' engineers suggested using TUBE-TURN Welding Returns, cut with templates as shown in the sketch. Costs came down. The dimensional uniformity of TUBE-TURN Welding Returns and Elbows simplifies fabrication jobs such as this because they can be cut to odd angles and adapted to special requirements.

TUBE TURNS IS AT YOUR SERVICE!


SECTION OF 8 CYL. DIESEL ENGINE AIR MANIFOLD SHOWING SEGMENTS OF TUBE-TURN ELBOWS USED AS INLETS
SKETCH SHOWING 3 SEGMENTS CUT FROM TUBE-TURN 180° RETURN WITH SUFFICIENT MATERIAL FOR REQUIRED SHAPING OF ENDS

Header connection design problem solved by Tube Turns' Engineering Service.



YOUR NEEDS in welding fittings and flanges are met *promptly* by your Tube Turns' Distributor. This one reliable source can fill *all* your requirements from the world's most complete line of welding fittings and flanges comprising more than 4,000 items.

ALUMINUM. To prevent contamination of the product, and assure permanently leakproof construction, this refinery's new TCR bead catalyst plant uses welded aluminum piping such as shown for certain services. TUBE-TURN Aluminum Welding Fittings and Flanges are used in this piping. Pipe sizes vary from 1" to 10".

Want Piping Information?

TUBE TURNS is recognized the world over for its leadership, not only in the field of welding fittings and flanges, but as a source of authentic information on piping design.

TUBE TURNS, Dept. H-3
224 East Broadway, Louisville 1, Kentucky

Please send me free copy of Pipe and Fittings Materials.

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Company Address _____

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"tt" and "TUBE-TURN" Reg. U. S. Pat. Off.

TUBE TURNS

LOUISVILLE 1, KENTUCKY

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

B.F.Goodrich

Acid bath gives irons shiny faces

Koroseal is a typical B.F.Goodrich product development

ELECTRIC irons wear a thin coat of chrome for protection, but what gives them real shine and permanence is the bright nickel beneath. The irons take their nickel bath in big tanks like the one in the picture. But the process used to be a headache.

The plating solution is so strong it would eat through wood and metal tanks. Leaks, danger to workers, constant repairs, expense were the result.

Then a sales engineer told the appliance maker about Koroseal, the flexible material developed by B. F. Goodrich, that stands practically all acids. A Koroseal lining was tried here, and is still working perfectly after seven years. No leaks, no repairs, no delays in production. Today, Koroseal is used in hundreds of places in industry, for "impossible" jobs that other materials can't touch.

Koroseal flexible material is only one example of the product development and improvement that is always going on at B. F. Goodrich. Every product B. F. Goodrich makes—V belts, conveyor belts, hose and many other things—is constantly being studied by practical engineers to see how it can be improved from the user's standpoint, how it can be made to last longer and do a better job. To take full advantage of B. F. Goodrich practical research, call your BFG distributor, or write *The B. F. Goodrich Company, Dept. M-222, Akron 18, Ohio.*

Koroseal—T. M. Reg. U. S. Pat. Off.

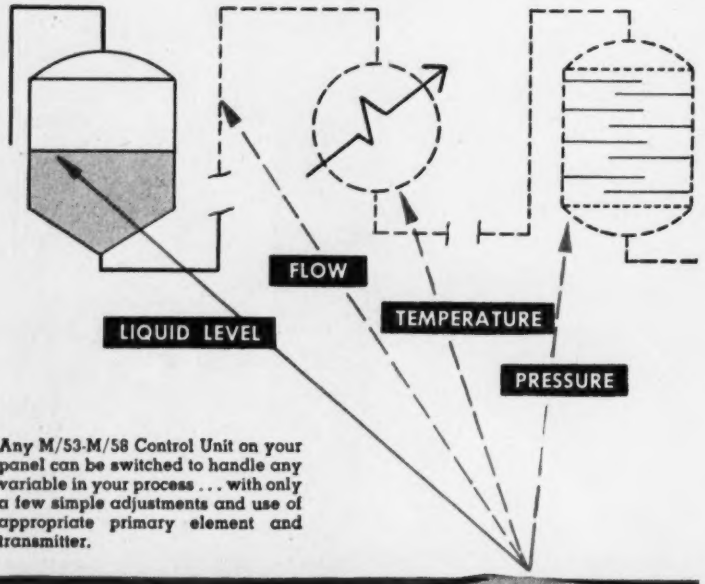
B.F.Goodrich
INDUSTRIAL PRODUCTS DIVISION

No obsolescence for this controller when process requirements change!

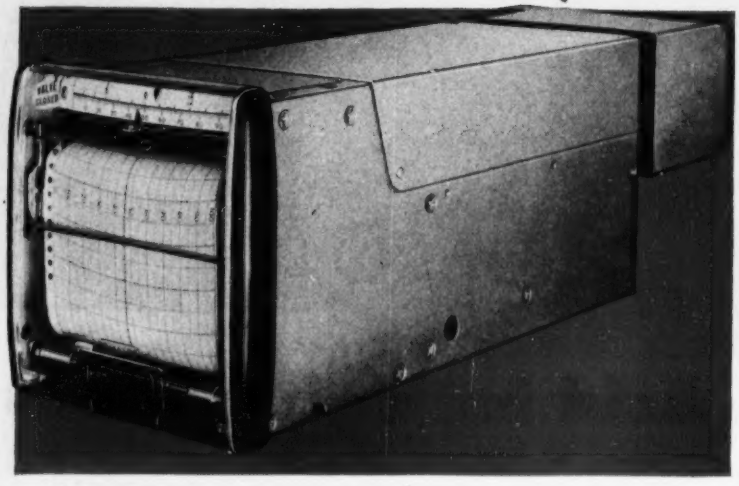
That's right! The Foxboro M/53-M/58 Recorder-Controller is a "universal" instrument, equally adaptable to any process measurement — whether flow, temperature, pressure, liquid level, or other.

All it takes is connection to the proper measurement transmitter having a 3-15 psi pneumatic signal . . . and making the appropriate controller settings. Changes such as adding derivative to reset or proportional control can be made *on the job* without special tools or realignments. You save needless duplication in capital investment . . . save time and trouble in making process revamps . . . and get the unsurpassed performance of M/58 control on every application!

Whether you favor graphic, console, or conventional mounting, you can cut instrument overhead at every stage, step-up efficiency in every operation, with the Foxboro M/53-M/58 Recorder-Controller. Write for complete information. **The Foxboro Company, 366 Neponset Ave., Foxboro, Mass., U.S.A.**



Any M/53-M/58 Control Unit on your panel can be switched to handle any variable in your process . . . with only a few simple adjustments and use of appropriate primary element and transmitter.



OTHER BASIC ECONOMIES

- **Simplified Ordering**
  —complex specification sheets are eliminated.
- **Reduced Stock Inventory**
  —only one type recorder-controller for all control jobs.
- **Reduced Maintenance**
  —fewest parts, rugged design, no diaphragms, highest quality throughout.

FOXBORO
REG U. S. PAT. OFF.

Consotrol Process Control

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

Another new development using

B. F. Goodrich Chemical *raw materials*

B. F. Goodrich Chemical Company does not make this rigid vinyl pipe. We supply the Geon resin only.

Right in the groove - rigid vinyl pipe

THIS is a part of a 3-mile installation of rigid vinyl plastic pipe in the oil fields of Ellis County, Kansas. It carries hot salt water—a corrosive by-product of crude oil—from a separating tank to a deep disposal well.

Oil company engineers chose *high-impact* rigid vinyl pipe made from Geon resin because it won't corrode, can stand roughest handling and has better chemical resistance. Another advantage: Money is saved in ditching operations for other pipe made of brittle materials must be cradled in a more costly graded ditch to avoid damage.

This high-impact rigid vinyl pipe has so many advantages that it may suggest a use to you or may give you an idea for an equally successful product. There are scores of other uses for Geon materials—from rigid sheets and panels to flexible colorful upholstery, wire insulation, durable flooring, sponge and many more. For information on Geon materials, please write Dept. GE-6, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

GEON RESINS • GOOD-RITE PLASTICIZERS . . . the ideal team to make products easier, better and more saleable

GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers • HARMON colors

HARSHAW FLUORIDES WORK

like magic

BORON TRIFLUORIDE

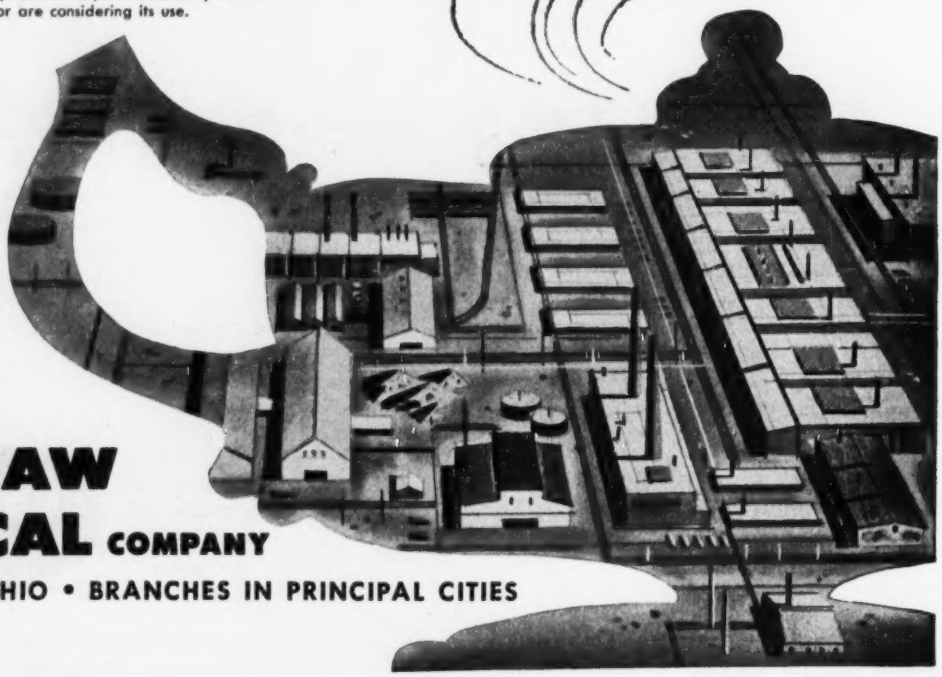
HYDROFLUORIC ACID

• ANHYDROUS • AQUEOUS

Here is an additional group of production-controlled, high-quality fluorides:

- Ammonium Bifluoride
- Ammonium Fluoborate
- Antimony Trifluoride Sublimed
- Barium Fluoride
- Bismuth Fluoride
- Boron Trifluoride
- Boron Trifluoride Complexes
- Chromium Fluoride
- Copper Fluoborate
- Fluorboric Acid
- Fluorine Cells
- Fluorinating Agents
- Frosting Mixtures
- Hydrofluoric Acid Anhydrous
- Hydrofluoric Acid Aqueous
- Hydrofluosilicic Acid
- Lead Fluoborate
- Metallic Fluoborates
- Potassium Bifluoride
- Potassium Chromium Fluoride
- Potassium Fluoborate
- Potassium Fluoride
- Potassium Titanium Fluoride
- Silico Fluorides
- Sodium Fluoborate
- Tin Fluoborate
- Zinc Fluoborate
- Zinc Fluoride

Write for Harshaw's 40-page Book on Hydrofluoric Acid Anhydrous. It provides helpful data for you if you now use HF or are considering its use.

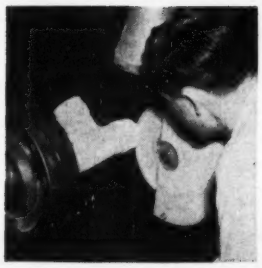


THE

HARSHAW CHEMICAL COMPANY

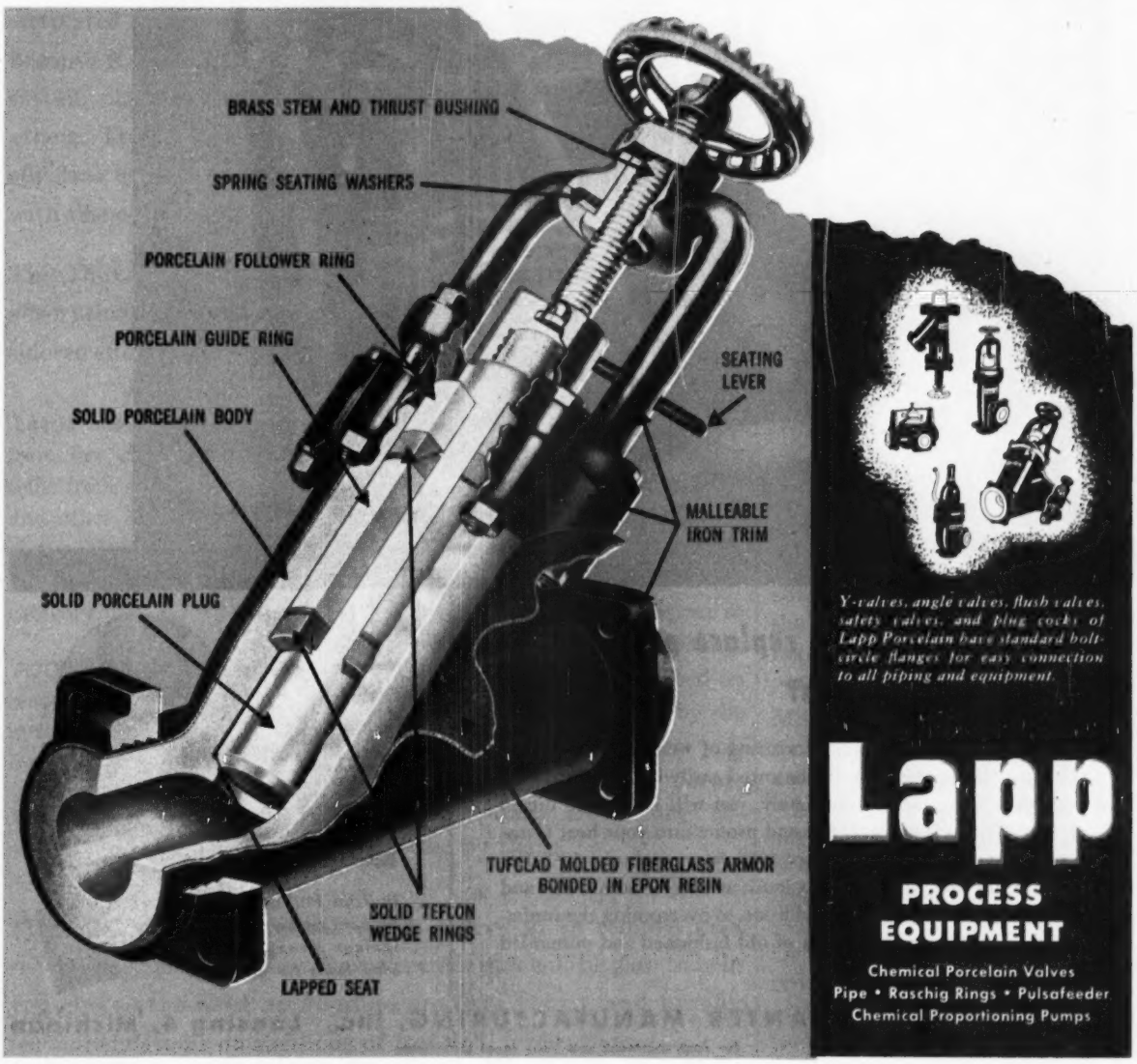
CLEVELAND 6, OHIO • BRANCHES IN PRINCIPAL CITIES

Precision Grinding of Solid Porcelain in the Lapp Valve



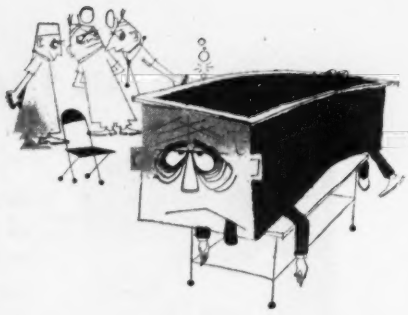
The high firing temperature, which assures complete vitrification and zero porosity of Lapp Porcelain, also makes impossible the maintaining of close dimensional tolerances. Necessary tolerances are achieved, however—in regular production ±.001"—by machine grinding with silicon carbide wheels. In the Lapp Valve, the entire stuffing box chamber, seating area, plug, guide and follower rings are finish ground, for precision assembly and complete interchangeability of parts. In addition, each porcelain plug is individually lapped and polished into its seat integral in the valve body. (No separable seating parts.) Each such valve seal is tested to 150 psi hydrostatic pressure before the valve is shipped.

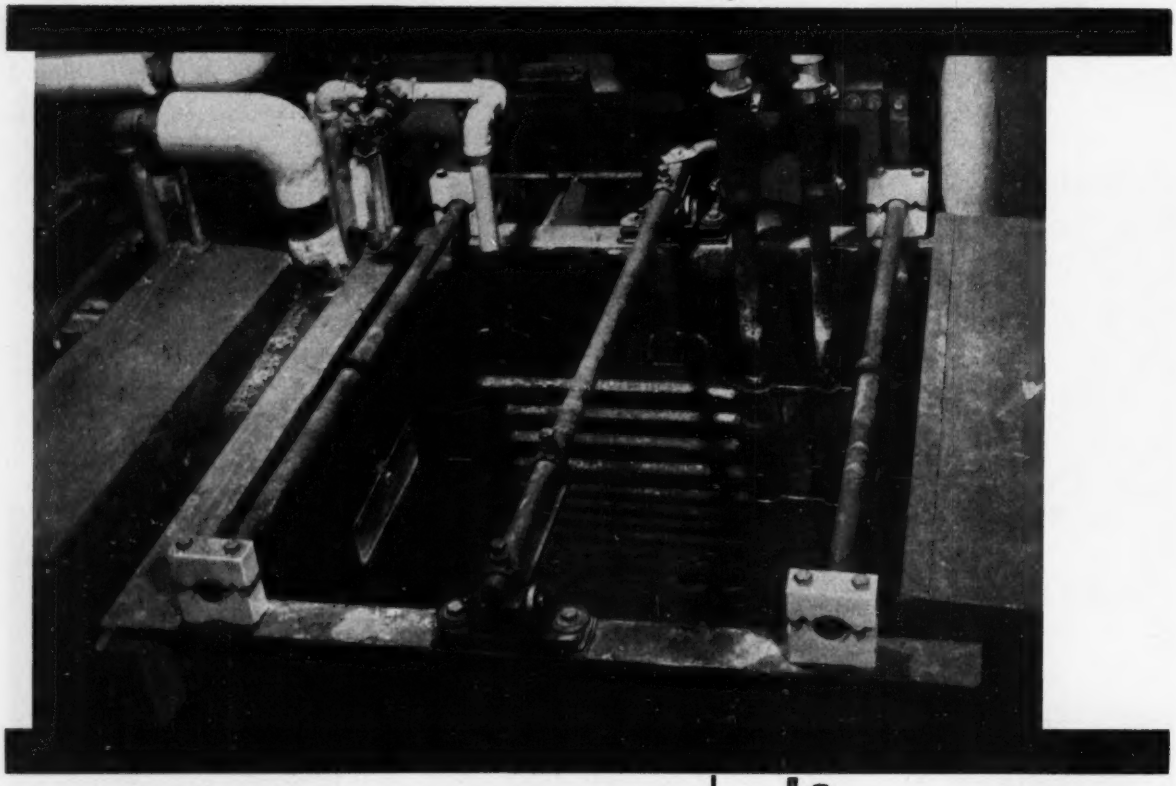
Write for bulletin with complete description, characteristics, and specifications. Lapp Insulator Co., Inc., Process Equipment Division, 303 Wendell St., LeRoy, New York.


BRASS STEM AND THRUST BUSHING
SPRING SEATING WASHERS
PORCELAIN FOLLOWER RING
PORCELAIN GUIDE RING
SOLID PORCELAIN BODY
SOLID PORCELAIN PLUG
SEATING LEVER
MALLEABLE IRON TRIM
TUFCLAD MOLDED FIBERGLASS ARMOR BONDED IN EPON RESIN
SOLID TEFLON WEDGE RINGS
LAPPED SEAT
Y-valves, angle valves, flush valves, safety valves, and plug cocks of Lapp Porcelain have standard bolt-circle flanges for easy connection to all piping and equipment.
Lapp
PROCESS EQUIPMENT
Chemical Porcelain Valves
Pipe • Raschig Rings • Pulsafeeder
Chemical Proportioning Pumps

new Wyandotte Research Laboratory uses PLATECOILS *to prevent coil-itis* *

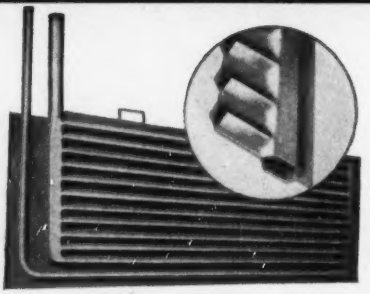
One of the finest technical laboratories in the country is the new Research Laboratory of Wyandotte Chemicals Corporation, Wyandotte, Michigan. A key feature of this laboratory is a series of 100-gallon plating and cleaning tanks made of various materials, such as rubber and plastic, which resist the actions of different types of chemicals. Individual tanks can be heated from room temperature to 212 degrees in less than an hour, by the Platecoil heat transfer units in the tanks. "We find Platecoil to be ideal because of their easy-to-clean surfaces and standardized performance," reports A. W. Liger, Supervisor of Industrial Research.



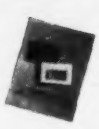


PLATECOILS *replace pipe coils for 50% of the cost*

* Coil-itis is the constant doctoring of wet processing tanks for pipe coil troubles. It can be cured easily by replacing pipe coils with Platecoils. Immediately, you will notice the difference as Platecoils put new life and profits into your heat transfer processes. They heat or cool 50% faster and take 50% less space in the tank. They save as much as 50% in initial cost and 50% in maintenance costs in addition to overcoming the limitations and operating difficulties of old fashioned and outmoded pipe coils.



Bulletin P61 shows how Platecoils are replacing pipe coils at a savings throughout industry. Send today for your copy.



Platecoil Division, TRANTER MANUFACTURING, inc., Lansing 4, Michigan

For fast shipment see your local distributor

DARCO Digest

DARCO DEPARTMENT • ATLAS POWDER COMPANY
Darco General Sales Offices—60 EAST 42nd STREET, NEW YORK 17, N. Y.
ATLAS POWDER COMPANY, CANADA, LTD., BRANTFORD, CANADA

Four Basic Types of Impurities Are Readily Adsorbed by DARCO

Activated carbon is useful as a chemical engineering process because it is a selective adsorbing material; that is, it removes certain classes of substances from solution more readily than others. The carbon can be processed so as to render it more effective against certain broad types of adsorbates. Selectivity with respect to a given material cannot, however, be imparted.

The Darco family of activated carbons are all intended for adsorption from solutions. As a rule of thumb, they are considered effective for removing these four general types of materials:

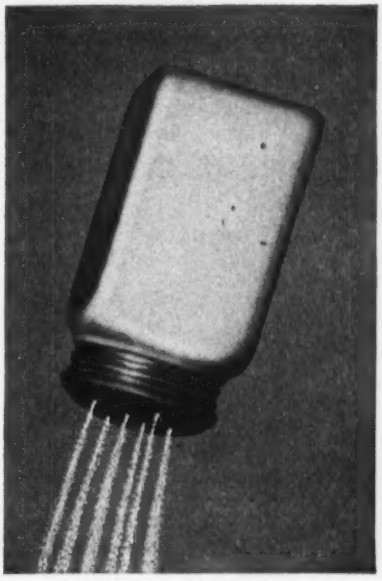
LARGE MOLECULES... fatty acids, from dry cleaning solvents; proteins from sugars such as lactose, and other compounds with complex molecular structure. Many color contaminants fall into this category.

POORLY SOLUBLE MATERIALS... are readily removed from solution, as in the case of the impurities causing chill haze in beer.

COLLOIDS... in this group are many agents which inhibit crystallization, cause haze, and impart color. Sugar intended for use in soft drinks can be purified of such colloids by Darco treatment.

SURFACE ACTIVE AGENTS... materials of this type tend to migrate to any interface which may be present, and are thus readily adsorbed on the large surface presented by the carbon. Troublesome foam producers, often present in minute concentrations, are readily adsorbed by Darco.

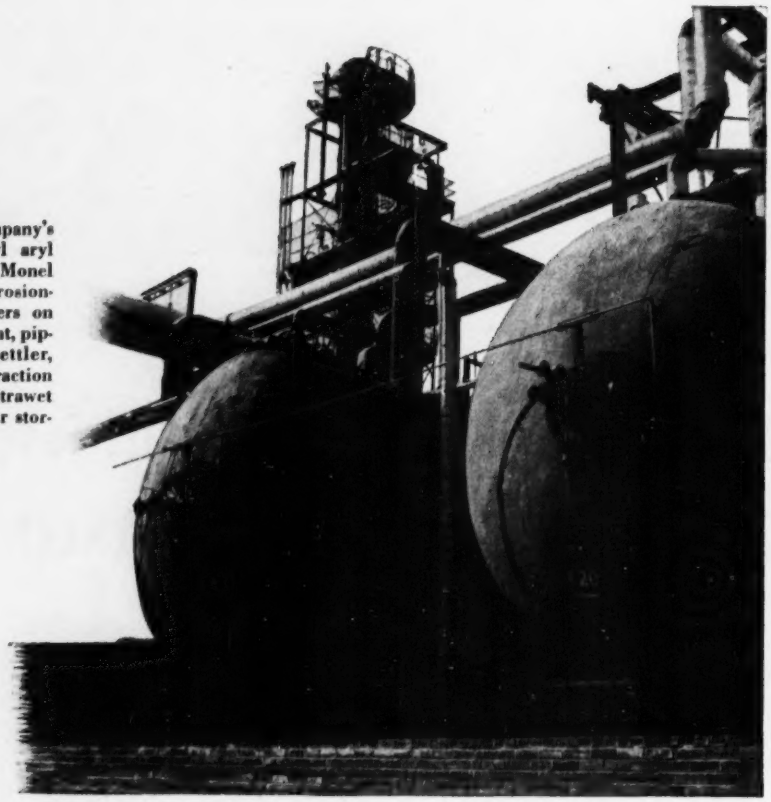
The particular contaminant which you wish to remove may require special techniques. Darco technicians will be glad to help you choose the most appropriate grade of Darco, and to offer recommendations on methods of test and application.



Taste-accentuating chemical decolorized with DARCO

Monosodium glutamate has the unique ability to stimulate the perception of taste. As an additive in a great variety of foodstuffs, it effectively enhances the flavor—to the extent that it may some day take its place beside salt and pepper on the table.

MSG is derived from such materials as beet sugar molasses residues and corn or wheat gluten. The original protein hydrolysate has anything but agreeable taste, and is dark as black coffee. By treatment with Darco activated carbon, the off-taste and color ingredients are thoroughly removed. From this process come pure white crystals of MSG, which are welcome additives in scores of food products.



At The Atlantic Refining Company's plant in Philadelphia, alkyl aryl sulfonates are evaporated in Monel evaporators. Atlantic uses corrosion-resisting Monel in condensers on benzene distillation equipment, piping, neutralization tank, settler, soap evaporators, solvent extraction equipment, steam coils in Ultrawet storage tanks and in tanks for storing 50% caustic soda.

How Monel protects against corrosion in

Synthetic Detergent Manufacture

It's no wonder that The Atlantic Refining Company, one of the largest detergent manufacturers in the country, relies heavily on corrosion-resisting Monel to protect important process equipment items against corrosion and to insure the high purity of its synthetic detergent "Ultrawet."

For there are plenty of places where corrosion can take hold in the manufacture of alkyl aryl sulfonate detergents.

Among the corrosives which occur in the process are: sulfuric acid, sulfonic acids, dilute hydrochloric and hot caustic soda. In addition there is the problem of contamination: even slight traces of metallic corrosion products in a detergent may cause unwelcome odors and instability.

Service in many fields has proved that Monel is often the most economical material where a strong, tough alloy is needed to handle acids, alkalies and salts with a minimum of corrosion or contamination. Monel is an easily-formed structural material whose corrosion resistance is not impaired by welding.

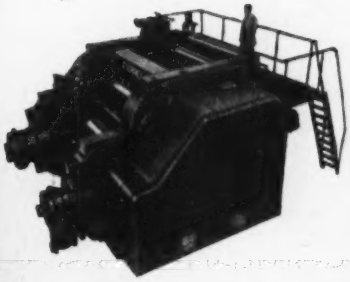
If you would like to know whether Monel or one of the other Inco Nickel Alloys can help solve your corrosion problem, write to Inco's Corrosion Engineering Section. Our Technical Bulletin T-5 "Engineering Properties of Monel and 'R' Monel" is yours for the asking.

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

Inco Nickel Alloys

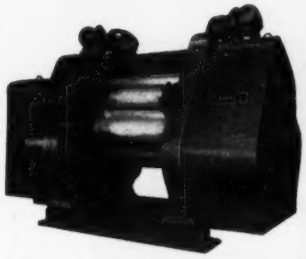
MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL • "S"® MONEL
INCONEL® • INCONEL "X"® • INCONEL "W"® • INCOLOY®
NIMONIC® ALLOYS • NICKEL • LOW CARBON NICKEL • DURANICKEL®

What is new in RUBBER and PLASTICS Processing Machinery?



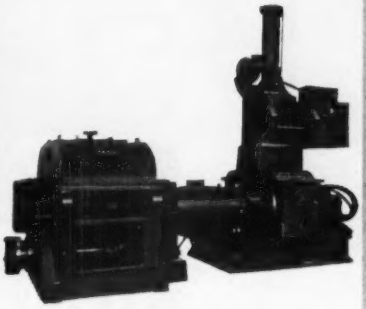
FOUR-ROLL "Z"* CALENDER

Ideal for high-speed production of film, sheet and coated fabrics. Roll arrangement, crossed axes device and other features permit finer control of gauge.



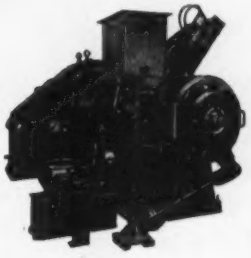
THREE-ROLL TRI-ANGULAR* CALENDER

The machine of the future for any type of production requiring two calender passes. Right-angle arrangement of rolls provides closer control of gauge and facilitates feeding.



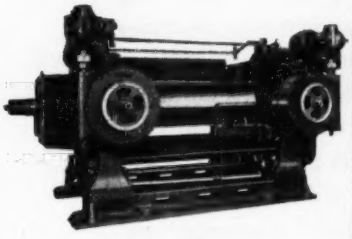
BANBURY* MIXERS

Uni-drive and other design features make possible faster mixing, better quality and lower production costs.



EXTRUDERS

Installed under Banbury mixers, receive stock directly without an operator. Stock strained and extruded, or extruded without straining, in continuous strip of uniform thickness and width.



ROLL MILLS

Farrel-Birmingham* mills are built in a complete range of sizes and with a wide choice of drive arrangements and attachments to suit any requirement.

As the world's largest manufacturer of machinery for processing rubber and plastics, Farrel-Birmingham has made many outstanding engineering contributions to the efficient conversion of raw material to finished or semi-finished product.

Among recent developments are the four-roll "Z" calender and the three-roll *Tri-angular* calender. Originated and developed by Farrel-Birmingham engineers, both of these designs are establishing new standards for accuracy and economy in calendering.

Other types of machines, such as Banbury mixers, mills, crackers and extruding machines, are constantly being modified and refined in design to improve production efficiency and reliability of operation.

Write for further information about any of the equipment mentioned on this page. Descriptive literature will be sent to you without cost or obligation.

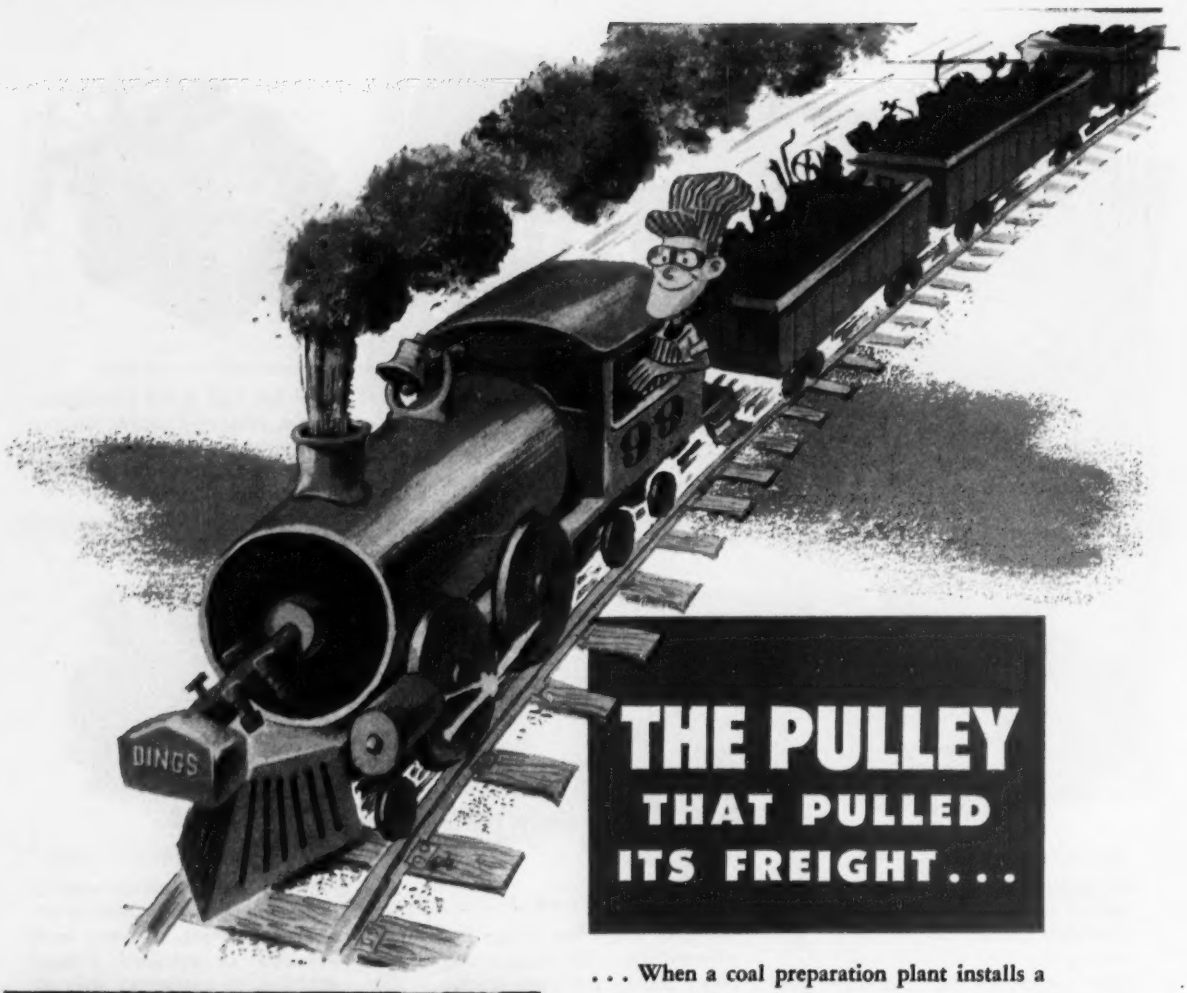
F-B PRODUCTION UNITS — Banbury Mixers • Plasticators • Pelletizers • Extruders • Calenders • Mixing, Grinding, Warming and Sheeting Mills • Refiners • Crackers • Washers • Hose Machines • Bale Cutters • Hydraulic Presses and Other Equipment for Processing Rubber and Plastic Materials

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT
Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Akron, Chicago, Los Angeles, Houston

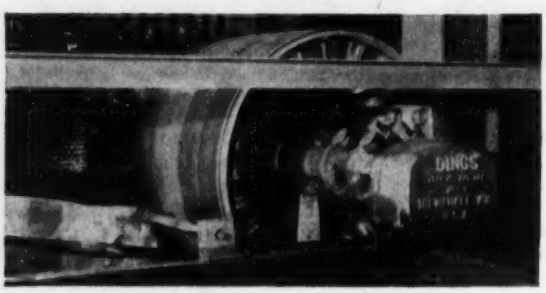
FB-829

Farrel-Birmingham ®

*Trade-marks of Farrel-Birmingham Company, Inc.



THE PULLEY THAT PULLED ITS FREIGHT...



This is the pulley that pulled its freight—amortized itself in 10 years while giving its owner an annual profit of more than $3.00 by salvaging its costs plus in scrap iron.

. . . When a coal preparation plant installs a magnetic pulley to protect equipment against bolts, spikes, cutter bits and other stray iron, the pulley is expected to cost something. But, a West Virginia producer found that his Dings Magnetic Pulley recovered scrap iron and tools of sufficient value (about $243 a year) to pay maintenance, power and depreciation costs ($239.64)—and show an annual cash profit of more than $3.00! Now the Dings pulley is still operating long after being amortized, and it's still bringing in that high annual return in scrap.

What is your tramp iron problem? Dings can solve it profitably. *Ask for Bulletin C-5000-B.*

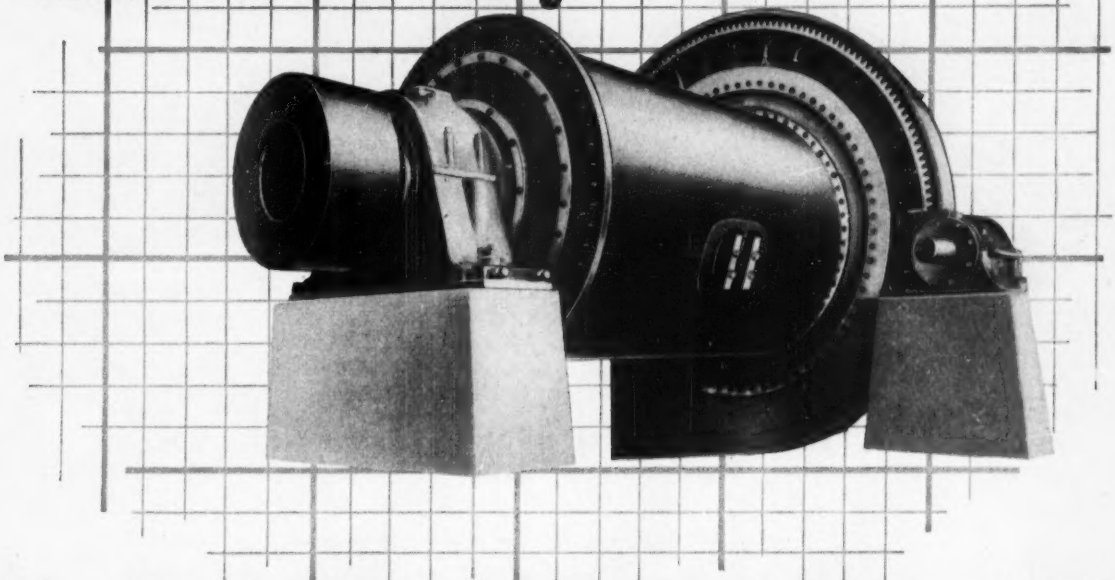
Dings

ELECTRIC AND NON-ELECTRIC MAGNETS FOR EVERY JOB

DINGS MAGNETIC SEPARATOR CO. • **4730 W. Electric Ave., Milwaukee 46, Wisconsin**

Magnetic Separation Leader for over Fifty Years

Here's the Inside Story!



It's the Design of Traylor Grinding Mills that improves quality...reduces operating costs

Every Traylor Grinding Mill is individually engineered and built to fit your own particular needs. As a result each mill delivers a uniform product . . . of the right fineness *for you.*

All main bearings on Traylor Ball, Rod and Compartment Mills are pressure lubricated. A high pressure pump coats each trunnion with a film of grease which lifts and floats the mill to overcome high starting torques and eliminates undue wear caused by "dry" starting.

Precision cut steel driving gears, trunnions cast integral with the detachable heads, shell liners of manganese or alloy steel . . . all indicate the improved design and construction features that are standard with Traylor.

Traylor
LEADS TO GREATER PROFITS

Illustrations and specifications on Traylor Grinding Mills will complete the "inside story" for you. Mail coupon for Bulletin 8121 today.

Please send Bulletin 8121 immediately.

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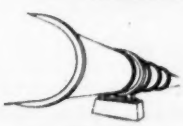
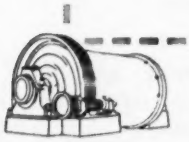
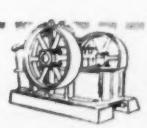
631 MILL ST., ALLENTOWN, PA.
Sales Offices: New York • Chicago • San Francisco
Canadian Mfrs: Canadian Vickers, Ltd., Montreal, P.Q.

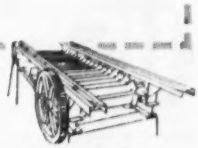
Primary Gyratory Crushers

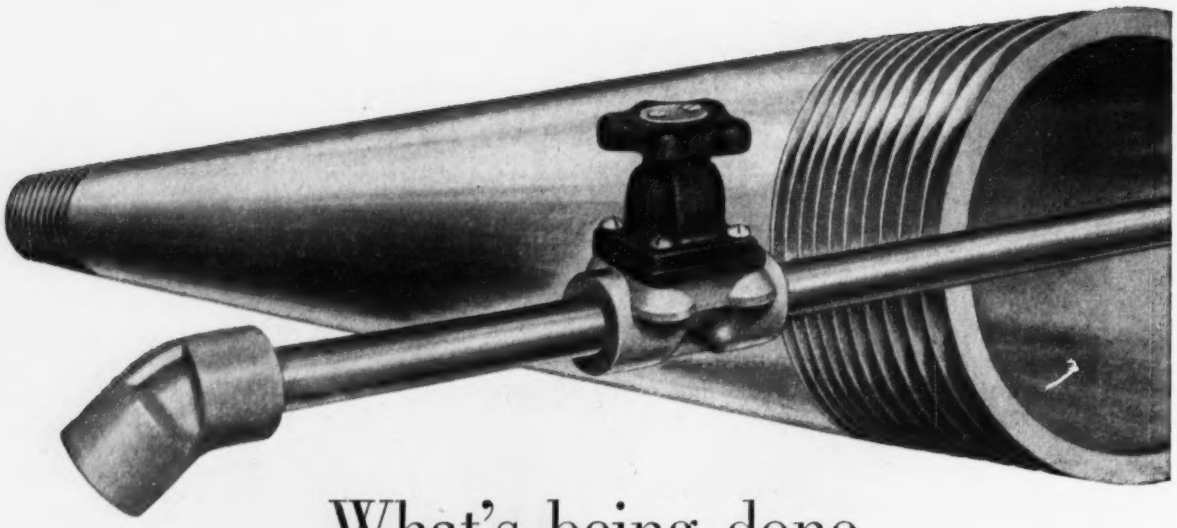

Rotary Kilns

Secondary Gyratory Crushers


Ball Mills


Jaw Crushers


Apron Feeders



What's being done with Plastic Pipe these days?

A great deal. Consider for example Uscolite® pipe, manufactured by United States Rubber Company. Uscolite is tough, rigid, lightweight, corrosion-resistant, makes a tight, firm joint.

When you say Uscolite is tough and strong, just how tough and strong do you mean?

Won't break if dropped or hammered. It needs no coddling. Can be set and threaded on the job with standard pipe tools. Stands up under the most severe conditions.

What will Uscolite pipe carry?

Uscolite has excellent chemical resistance. It's especially recommended for carrying corrosive chemicals and materials sensitive to contamination. It's valuable for piping through highly humid and corrosive atmosphere. It works under the most severe conditions.

Is Uscolite a new product?

No. Uscolite pipe and fittings have been proved by years of service in thousands of installations in dozens of different industries.

Is Uscolite difficult to install?

On the contrary. It is available in both the standard and the extra-heavy wall iron pipe sizes. It is easy to cut and thread with standard equipment and install without special precautions. The pipe can be drilled, tapped, sawed and machined.

Is the Uscolite line complete?

Yes. It includes elbows, tees, flanges, couplings, reducing bushings, caps, valves—everything to make a complete pipe assembly.

How do I know if I can use Uscolite in my own business?

The odds say overwhelmingly that Uscolite pipe and fittings can save you money. Call on any of our 26 District Sales Offices, each staffed with engineers, to help solve any of your corrosion problems. Or see any of our selected distributors, or write to address below.

"U.S." Research perfects it . . ."U.S." Production builds it . . . U.S. Industry depends on it.

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UNITED STATES RUBBER COMPANY

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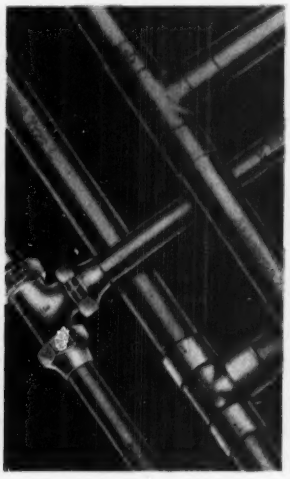
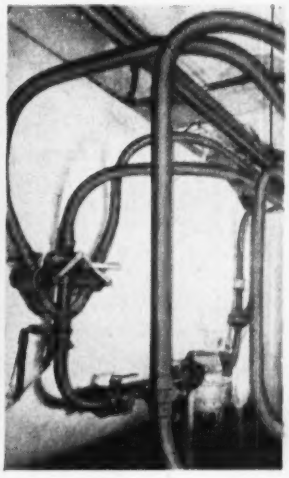
5 reasons why it costs less to install and maintain copper piping

1. **JOINS QUICKLY.** Modern solder-type connections eliminate threading. Strong, sound, smooth-interior assemblies are made at lower cost.

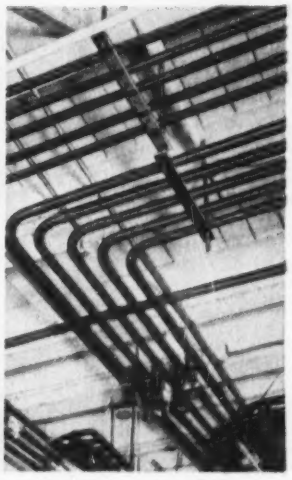
2. **HANDLES EASILY.** Replacement of old piping is easily and quickly accomplished with soft annealed ANACONDA Copper Tubes in coils.



3. **WON'T RUST.** ANACONDA Copper Tubes stay smooth and clean inside. No rusty scale can form to accumulate built-up deposits.



4. **NEEDS FEWER FITTINGS.** ANACONDA Copper Tubes come in long lengths. They save cutting, reduce the number of fittings needed.



5. **BENDS TO CLEAR OBSTRUCTIONS.** Soft-annealed ANACONDA Copper Tubes can be bent on the job to clear beams, girders, etc.

FREE BOOKLET! Publication B-1 gives more information on why it costs less to install and maintain copper piping. Write to: *The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.* 5415

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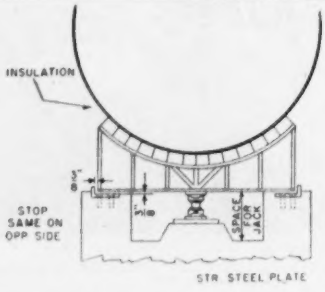
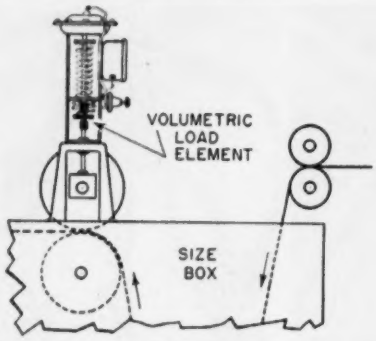
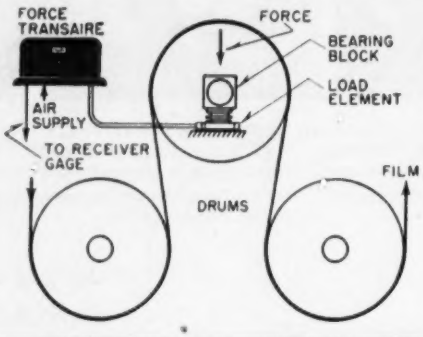
ANACONDA®

COPPER TUBES AND FITTINGS

*Also: Red Brass Pipe; PG's** (Pre-formed Panel Grids) for Radiant Panel Heating.*

Let us take a load off your mind !

DO YOU have a tricky load measurement problem on your mind? Something like measuring the tension on a conveyor belt for example, or the thrust on a bearing, or the weight of solids or corrosive liquids in a tank . . . ? Taylor volumetric load measuring elements have been used for years in paper mills, but there are many applications throughout the industry where these highly accurate and sensitive instruments are proving invaluable. Most recent developments afford a wide variety of ranges, greater range suppression, greater over-range protection and greater energy for positioning the pen or actuating a control mechanism. Applicable to tension and compression loads. Call your Taylor Field Engineer or write for **BULLETIN 98232.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

PROBLEM	SOLUTION	CHARACTERISTICS
To accurately measure the weight of chlorine in tanks		**Spool type Load Measurement Element** **Range limits:** 0-240,000 lbs. for compression loads, maximum load not to exceed 400,000 lbs. Applicable to horizontal or vertical tanks, containing corrosives or solids, making conventional level measuring devices impractical. Tension loads 0-30,000 lbs.
To accurately measure squeeze roll pressures on textile slashers		**Diaphragm type Load Measuring Element** **Range limits:** 0-5,000 lbs., maximum load not to exceed 6250 lbs. Compound ranges, tension—0—compression also available. Applicable to measure roll or nip pressures in calender stacks, press section and many other finishing operations involving processing of material between rolls.
To measure film tension within very close limits as a measure of "gain" or percentage of stretch		**Transaire Volumetric Load Measuring Element** **Range limits:** 0-300 lbs. in range spans as short as 30 lbs. Used in conjunction with a TANSAIRE* Pressure Transmitter which sends an output air pressure to an indicating, recording or controlling receiver proportional to the force applied. Applicable to film, paper, yarn or similar tension measuring requirements.

*Reg. U.S. Pat. Off.

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST

Solvents can't start trouble

. . . because a Chempump* has no seal!

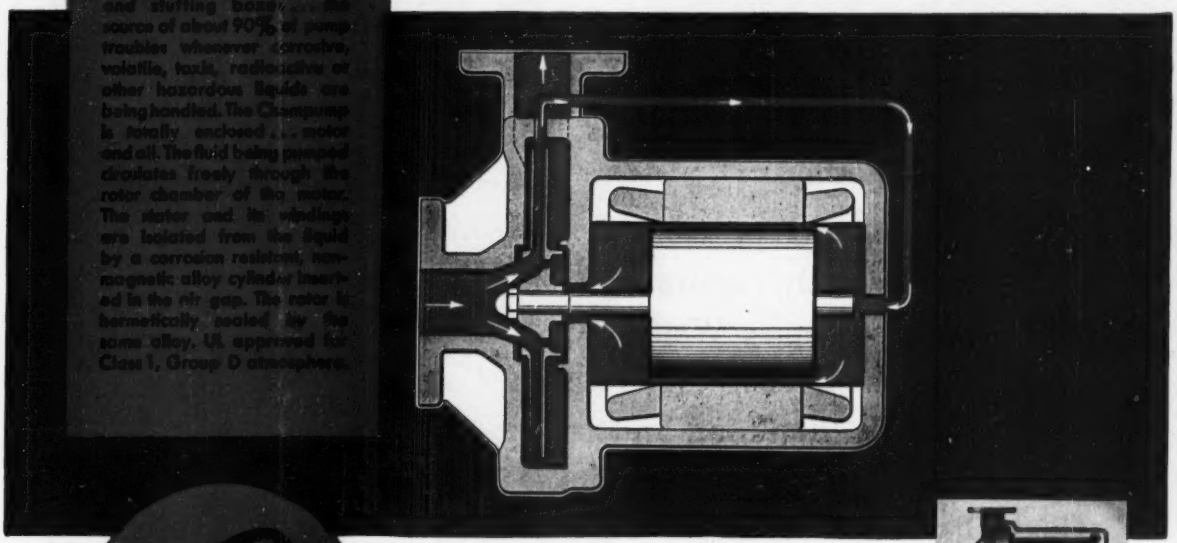
Because there is no seal, trouble just doesn't have a chance to start in a Chempump. There are no mechanical seals to fail. No stuffing boxes to pack or adjust. No lubrication required. The combined rotor and impeller assembly is the only moving part and it can be replaced quickly and easily . . . without breaking piping connections.

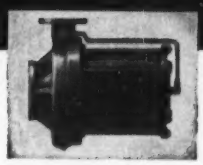
You'll have no fluid losses from a Chempump either. Toxic, hazardous or valuable fluids can't escape. Besides protecting your plant and personnel, the enclosed design protects the fluid from external contamination . . . an important consideration for vacuum applications with flooded suction.

The Chempump is available in ⅓, ¾, 1, 2, and 3 horsepower sizes . . . open or enclosed impeller. Standard materials are cast iron, 300-series stainless steel or Monel. Special materials available on request.

For complete information and performance data, clip the coupon and send it in.

The Chempump is a new concept in pump design that completely eliminates all seals and stuffing boxes . . . the source of about 90% of pump troubles whenever corrosive, volatile, toxic, radioactive or other hazardous liquids are being handled. The Chempump is totally enclosed . . . motor and all. The fluid being pumped circulates freely through the rotor chamber of the motor. The stator and its windings are isolated from the liquid by a corrosion resistant, non-magnetic alloy cylinder inserted in the air gap. The rotor is hermetically sealed by the same alloy. UL approved for Class 1, Group D atmospheres.





Chempump

CHEMPUMP CORPORATION • 1322 E. Mermaid Lane • Phila. 18, Pa.

Chempump is the result of experience gained from over 15,000 field installations on seal-less pumps.

CHEMPUMP CORPORATION • 1322 E. Mermaid Lane • Phila. 18, Pa.

Please send complete Chempump performance data.

Name ..... Title .....

Company .....

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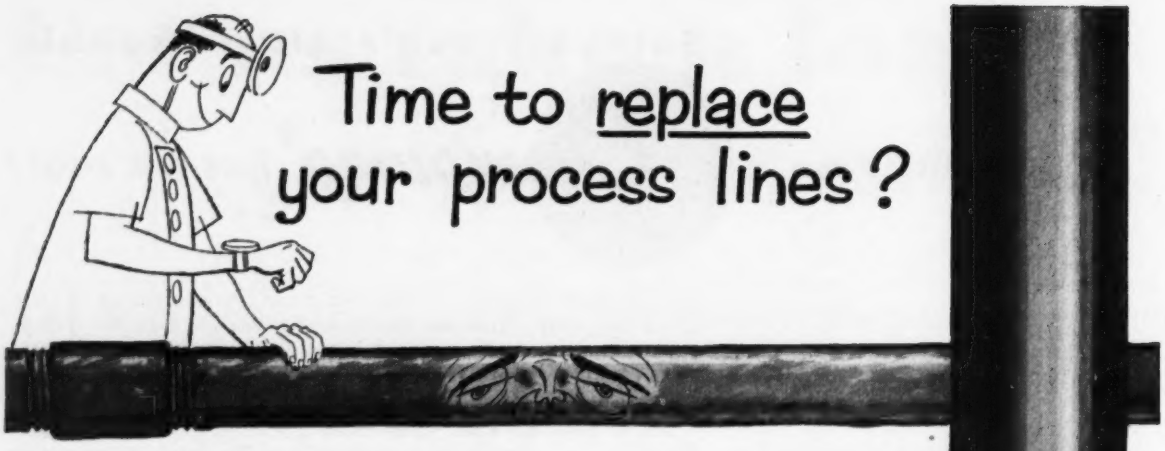


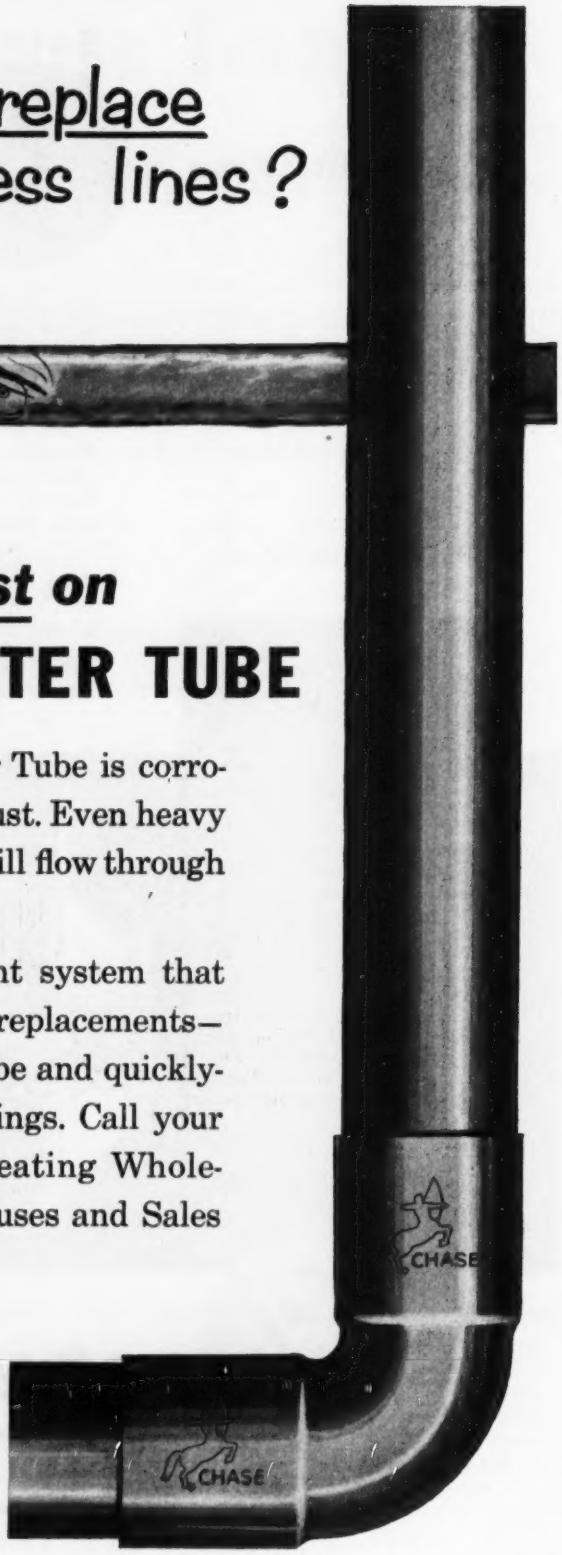
Time to replace your process lines?

This time, insist on

CHASE® COPPER WATER TUBE

Here's why: Chase Copper Water Tube is corrosion-resistant. It can't clog with rust. Even heavy industrial fluids like paper pulp will flow through it cleanly, smoothly.

For a leak-proof, pressure-tight system that will save you costly repairs and replacements—insist on Chase Copper Water Tube and quickly-installed Chase Solder-Joint Fittings. Call your nearest Chase Plumbing and Heating Wholesaler or one of the Chase Warehouses and Sales Offices listed below.



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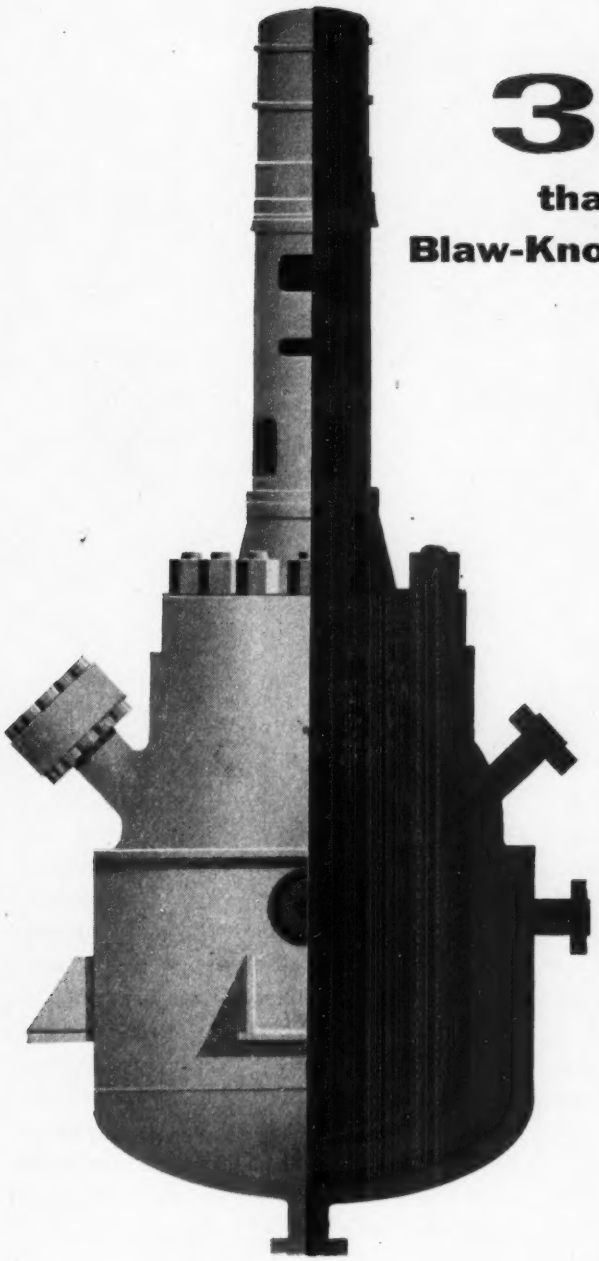
engineering knowledge
fabricating skill
facilities . . .



3 important factors that make Blaw-Knox Autoclave-Reactors more reliable

Few pieces of process equipment require as much of a manufacturer's engineering knowledge, fabricating skill and facilities as an autoclave-reactor.

High temperatures and pressures, varying operating conditions, corrosion, charging and discharging, agitating, heating, control and safety instrumentation—all are important considerations.

- When you buy a Blaw-Knox Autoclave-Reactor you draw upon the *engineering knowledge* of specialists in each of these important phases of autoclave-reactor design.
- For the construction of your autoclave-reactor, you can depend upon the *fabricating skill* of men responsible for the one factor upon which the Blaw-Knox reputation is built—quality.
- Blaw-Knox *facilities* include seven large modern plants which specialize in the fabrication of ferrous and non-ferrous equipment, piping, and the production of heat and corrosion-resisting castings.

These are important factors to consider in the specification of an autoclave-reactor. They are the factors that make Blaw-Knox Autoclave-Reactors more reliable.

Blaw-Knox builds autoclave-reactors in any capacity, for any pressure, temperature or reaction. When you buy, be sure to specify Blaw-Knox.

Write for catalog 2413.

BLAW-KNOX

BLAW-KNOX COMPANY

Blaw-Knox Equipment Division
Process Equipment Department
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A NEW IMPORTANT DEVELOPMENT!

RHODIUM CATALYSIS...

You can now gain many important production advantages with Rhodium Catalysts—a new and unique Baker development. It is successfully simplifying catalytic processing and effecting considerable savings for many chemical and pharmaceutical manufacturers.

The new Baker Rhodium Catalyst saturates ring and aromatic compounds at *normal temperature and atmospheric pressure.* It greatly reduces capital investment that would otherwise be required for high temperature and high pressure processing . . . it limits fire hazard . . . no special catalyst preparation is required. ★ ★ ★ ★ ★

As with all Platinum Metals Catalysts, you also benefit from close production control, high activity, high yield, purity of end product and the economy of the re-use feature of the Platinum Metals.

Production experience indicates strongly that the advantages of Rhodium Catalyst are sufficiently important to warrant your early consideration. A Baker Research Representative will be pleased to visit your plant or we'll be glad to send more complete data upon written request. ★ ★ ★ ★ ★

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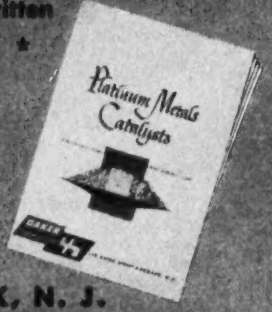
PLATINUM METALS CATALYSTS, Notes on Their Uses and a list of their most available forms.



BAKER & COMPANY, INC.
CATALYSTS

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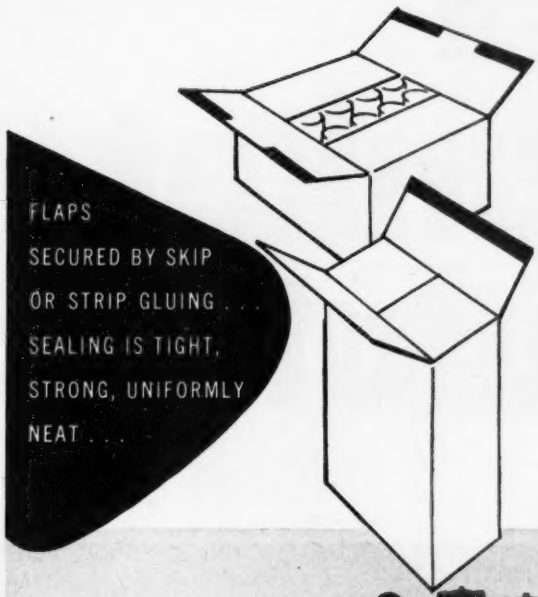
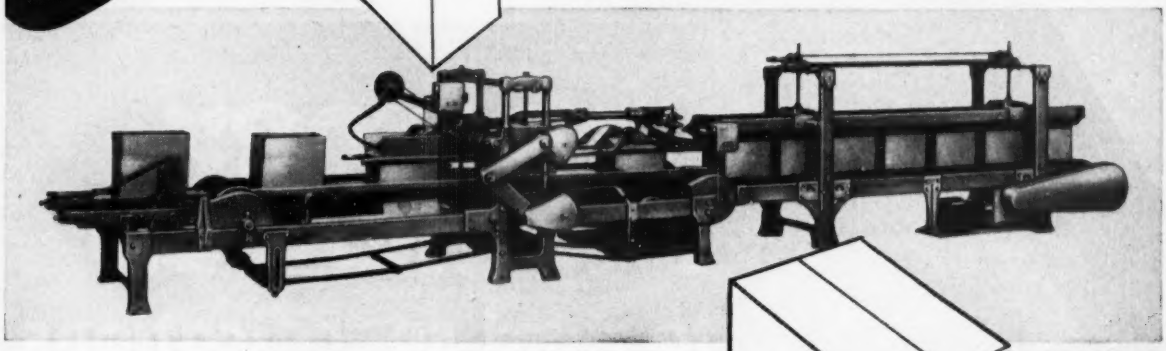
THE HUB OF PLATINUM METALS RESEARCH



FLAPS SECURED BY SKIP OR STRIP GLUING . . . SEALING IS TIGHT, STRONG, UNIFORMLY NEAT . . .

PROVEN FORMULA FOR SAVINGS IN CASE SEALING . . .

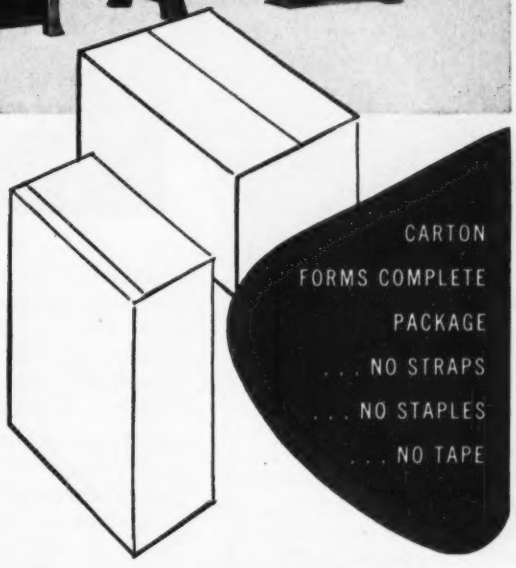


. . . automatic gluing and sealing on Standard-Knapp equipment

Standard-Knapp Gluers and Sealers are easily integrated into your operations. These machines greatly increase the number of cases that can be prepared for shipment within a given period. You can release employees for assignment to more important tasks.

Extra fastenings such as staples, strapping or tape are not required. Case sealing on Standard-Knapp equipment is strong and meets all transportation regulations. You have a wide choice of models to meet your exact requirements. High speed automatic models for volume production lines, self-adjusting types for handling varying case sizes at random and semi-automatic units for intermittent operations.

For more information about Standard-Knapp equipment, contact our nearest sales office or write Dept. V for catalogs.



CARTON FORMS COMPLETE PACKAGE . . . NO STRAPS . . . NO STAPLES . . . NO TAPE

STANDARD-KNAPP

DIVISION OF EMHART MFG. CO.

PORTLAND, CONNECTICUT

FULL S-K LINE FOR CHEMICAL INDUSTRY

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EAGLE-PICHER

Blanket Insulation

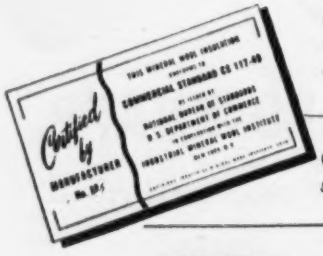
FACTORY FABRICATED ...to rigid specifications

FACTORY FABRICATION means that every blanket is made up of many felted layers of Eagle-Picher Mineral Wool—with ends overlapped to form smooth, firm edges that can be tightly, efficiently butted together.

FACTORY FABRICATION prevents large "voids" so often found in field-fabricated blankets where insulation is simply packed in place. Rigidly controlled production methods assure efficient mineral fibers are evenly dispersed over the entire insulating area.

FACTORY FABRICATION offers extra-sturdy, flexible construction . . . a blanket that lends itself to scores of uses. Copper bearing steel laths—bound by *uniformly spaced* soft-drawn galvanized tie wires—keep the blankets firm but flexible.

PROFIT from the advantages factory-fabricated insulating blankets can give you in your operations. Get Eagle-Picher Blankets for all of your important jobs.



CERTIFIED *to conform to Commercial Standards CS-117, as shown by the Certification seal on each blanket. Also conforms to Federal Specification HH-1-563.*

Since 1843

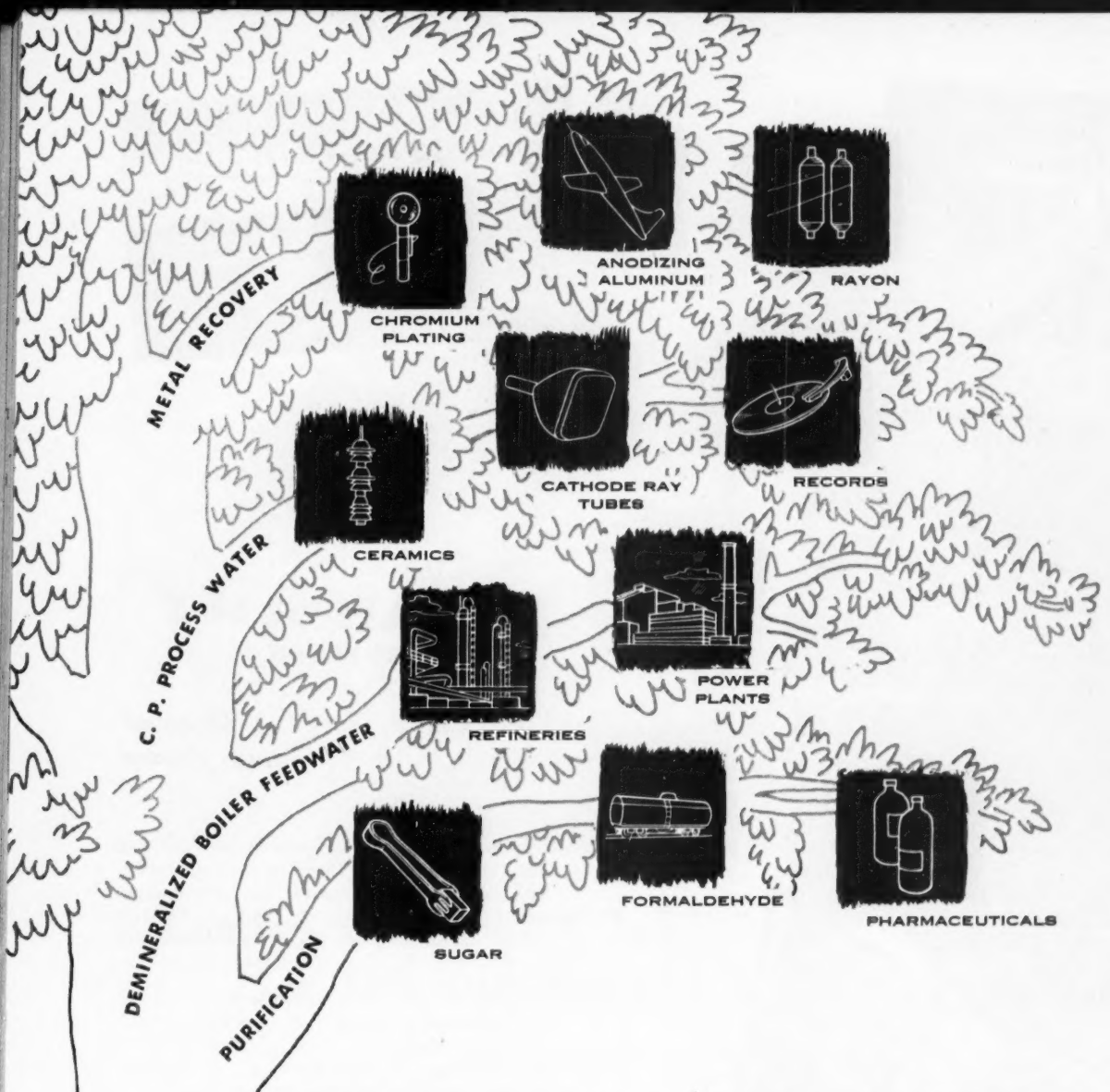
EAGLE EP PICHER

THE EAGLE-PICHER COMPANY

General Offices: Cincinnati (1), Ohio

For greater efficiency, protection and economy, you should specify these Eagle-Picher products:
Insulating Felts • Insulating Block • Blankets • Loose Wool • Mineral Wool Pipe Covering • Stalastic Stamastic • Insulseal • Finishing Cements • Insulating Cements • Swetchek • Insul-Stic • Fireproofing Cement

Member of Industrial Mineral Fiber Institute



How versatile is ION EXCHANGE?

If you define "versatility" as the ability to do many jobs, ion exchange more than fills your needs.

Shown above are just a few applications of Permutit Ion Exchange resins and equipment. Newer ones are being discovered almost daily. Ideas that solve problems, improve products. And often provide a handsome return by cutting costs or salvaging valuable materials from wastes.

Take chromium plating as an example. An ion exchange process *originated* by Permutit improves the operation in many ways. It demineralizes the rinse water, gives a better finish. It also recovers costly chromic acid from rinse water for re-use. Rinses can then be recycled, saving both water and fuel . . . eliminating waste treatment problems.

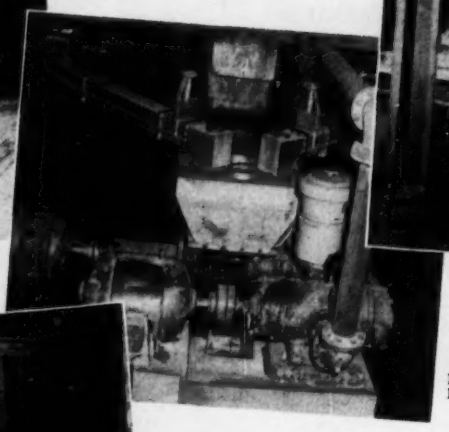
In addition, it purifies the baths—which maintain full electrolytic efficiency, last indefinitely. Greatly reduced dumping of the baths ends stream pollution problems.

Perhaps this suggests profitable applications in your business. Your research department may add others. We'll gladly send technical data and resin samples. Write to THE PERMUTIT COMPANY, Dept. CE-6, 330 West 42nd Street, New York 36, N. Y., or Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

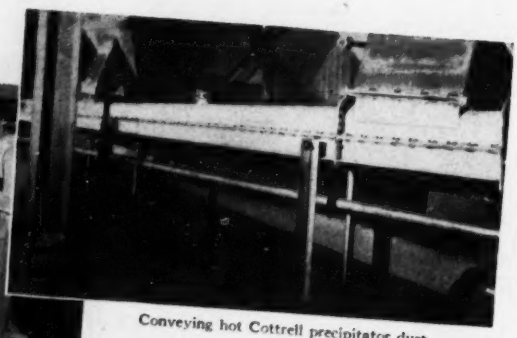
ION EXCHANGE HEADQUARTERS FOR OVER 40 YEARS

PERMUTIT®

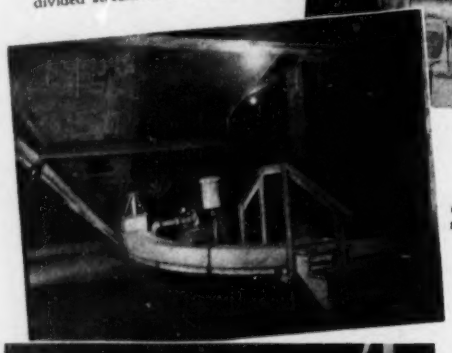
Airslide split to convey accurately divided stream to two pulverizers.



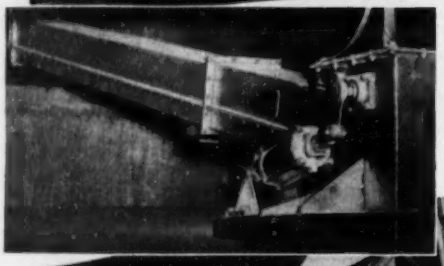
Pulverized limestone from bins to a Fuller-Kinyon Pump.



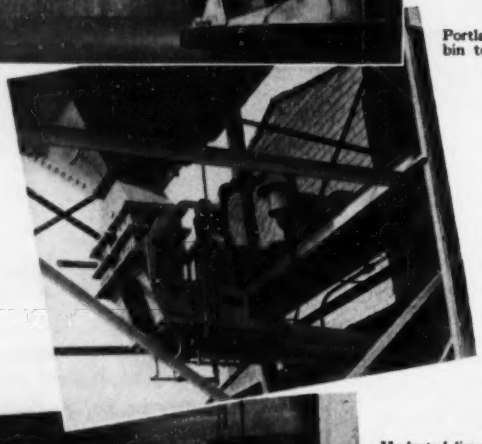
Conveying hot Cottrell precipitator dust.



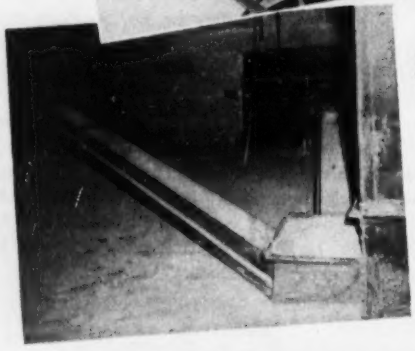
Cement raw materials, storage bin to elevator.



Talc from flat-bottom bin. Air-motor-operated cut-off gate to control flow.



Portland cement from bin to scales in plant.



Hydrated lime from bin to elevator.

F-H AIRSLIDE®
CONVEYOR

Safe, Clean, Fast . . . Greater Capacity with Minimum Power

For sheer simplicity, low maintenance, and operating costs, the F-H Airslide Conveyor is hard to beat. *Safe*, because there are no hazardous, moving parts. *Clean*—materials are entirely enclosed. *Fast*—moves material at greater speed, with considerably less horsepower than the conventional type conveyor.

There are many sound reasons for the widespread and enthusiastic acceptance of the Airslide by economy-minded operators in food and chemical processing plants for conveying many types of dry, fine materials. Repairs and costly down-time are at the minimum; no lubrication; easily erected; a space saver; permits flexibility of plant design not available with straight-line, mechanical conveyors.

Why not have our engineers show you how the Airslide can help cut your conveying costs? Chances are that a minimum expenditure can bring you a conveying system that means low-cost, reliable operation.

Fuller Company is the exclusive manufacturer of air gravity conveyors, except for use in motor vehicles, under Huron Portland Cement Company U. S. Patent Nos. 2,316,814, 2,517,837, 2,527,394, 2,527,455, 2,527,466, 2,527,488, 2,589,968 and Patents Pending.

DRY MATERIAL CONVEYING SYSTEMS
AND COOLERS—COMPRESSORS
AND VACUUM PUMPS—FEEDERS
AND ASSOCIATED EQUIPMENT

FH-34

Fuller

FULLER COMPANY, Catasauqua, Pa.
120 So. LaSalle St.—Chicago 3
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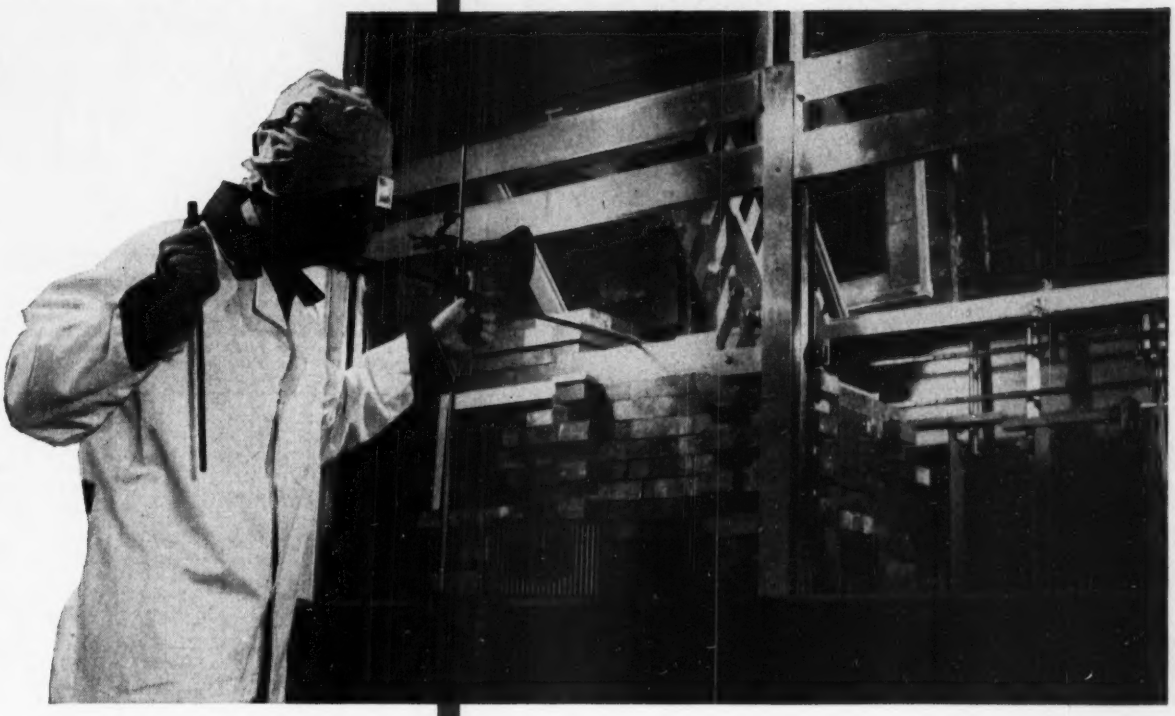
"Hot" cave for experimental work with radioactive materials. Window sash and frame are stainless steel. More uses for ENDURO include ventilating ducts, wall liners, counter tops, storage tanks, tongs and instruments, sinks and cleaning equipment, piping and tubing.



Cooling off a "HOT" lab IS A JOB FOR ENDURO STAINLESS STEEL

Planning to use or to work with radioisotopes? Then, you'll be interested in the bonus benefits ENDURO Stainless Steel offers.

Stainless steel originally was specified for radioisotope experimental equipment because it was most easily deactivated; it is easy to wash down, easy to keep clean. Its nonporous surface lessened the possibility of walls "soaking up" radioactive matter.

Cleanability still is the number one reason for the use of stainless steel in "hot" labs, where radioisotopes are handled. But, when you buy ENDURO equipment for one quality, you automatically get all its other benefits as a bonus. Such as resistance to rust and corrosion. Resistance to most acids and alkalies. Good dimensional stability and strength at both ends of the thermometer. High strength, without excess bulk. Sparkling appearance that stays handsome year after year. Ease of fabrication to your specifications.

Cooling off a "hot" lab is one job ENDURO can do for you. It can also contribute greatly to the success of other processes and products. Republic metallurgists will help you apply its bonus benefits. Just write:

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Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N. Y.

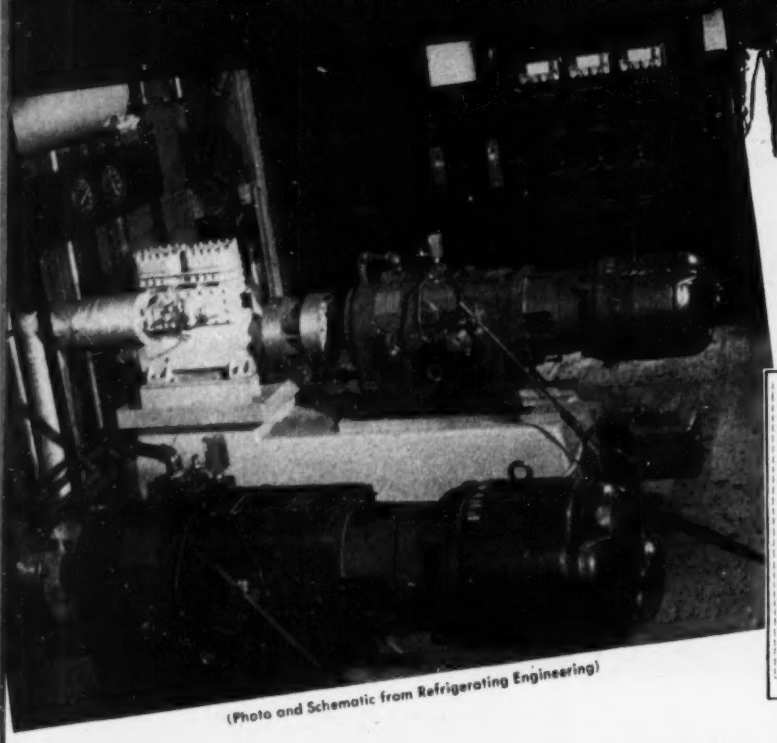
REPUBLIC STEEL

REPUBLIC
ENDURO STAINLESS STEEL

Other Republic Products include Carbon and Alloy Steels — Titanium — Steel and Plastic Pipe, Bolts and Nuts, Tubing, Barrels and Drums

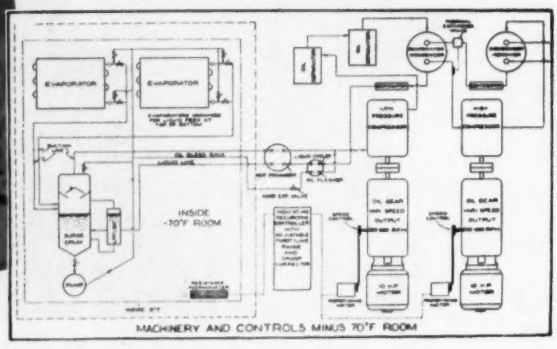
A STEADY *102°* BELOW FREEZING

. . . CALLED FOR CONTINUOUSLY VARIABLE SPEEDS AND STABLE OUTPUT TORQUE



(Photo and Schematic from Refrigerating Engineering)

Two Oilgear Fluid Power Transmissions driving compressors for research laboratory's —70 degree testing room. (Other Oilgear Transmission drives compressor for 0 degree room.) Output speed of transmissions varies according to temperature differential upon resistance thermometers. Control of speed is entirely automatic. Manual control for starting is optional. Oilgear Fluid Power Drives and compressors operate continuously. (See schematic below).



MACHINERY AND CONTROLS MINUS 70°F ROOM

OILGEAR *Fluid Power* SOLVED THIS PROBLEM

The wide range of installations that demonstrate the reliability, scope and ease of control of Oilgear Fluid Power Drives and Transmissions grows daily. A case history from REFRIGERATING ENGINEERING, official journal of the American Society of Refrigerating Engineers, telling how a research laboratory chose Oilgear Transmissions and obtained continuous, dependable performance without delay, is another chapter in that story.

Demands for tests of materials at extreme temperatures called for equipment able to hold testing room temperatures stable at all times—usually at 70° F. below zero. It also had to refrigerate test materials as rapidly as possible. This meant a system of varying compressor speeds automatically—so as to compensate for variations in heat load.

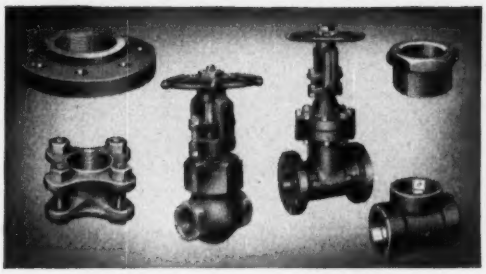
Previous experience had shown that . . . the use of direct current motors, or variable speed drives of the belt-and-pulley type, under automatic control, was not entirely reliable and required considerable servicing.

Then Oilgear Fluid Power Transmissions were adopted. These transmissions provide continuously and automatically variable output speed and maximum output torque at all operating speeds. Nearly two years' experience reveals that temperatures have been maintained within ±½° F. of the desired figure over long periods of time, that no attendant is required except for a few minutes' daily routine inspection, that the Oilgear drives are completely reliable.

Thus the evidence grows that if you are tired of machine or process drives and transmissions that don't stand up, if you want simpler, better, more productive and dependable drives, if you have problems not yet solved, it will pay you to contact Oilgear Fluid Power engineers. THE OILGEAR COMPANY, 1579 W. Bruce St., Milwaukee 4, Wis.

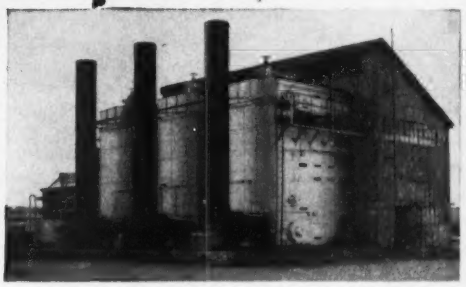
Oilgear Fluid Power

Designed for today's *Tough* service demands



DROP FORGED VALVES AND FITTINGS FOR TOUGHNESS AND TROUBLE-FREE SERVICE

Drop forged from carbon and alloy steels, Vogt valves, fittings and flanges will safely handle liquids and gases at high pressures and high temperatures in power plants, chemical plants, petroleum refineries, etc. The complete line includes flanged, screwed and socket weld end globe, gate and check valves—ells, tees, and crosses—couplings—bushings—plugs—unions—flanges and flange unions—and welding heads.

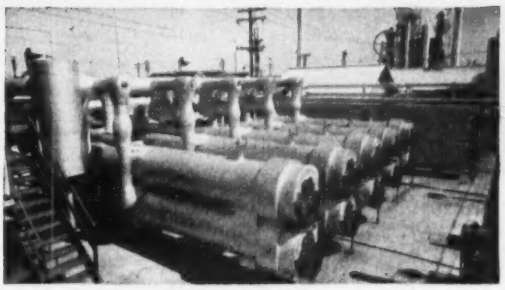


MODERN STEAM GENERATORS

Vogt steam generators are designed to give maximum rating in a minimum of space, with high efficiency and low maintenance expense. Bent tube types and straight tube, forged steel sectional header types to burn solid, liquid or gaseous fuels meet every power, process or heating requirement.

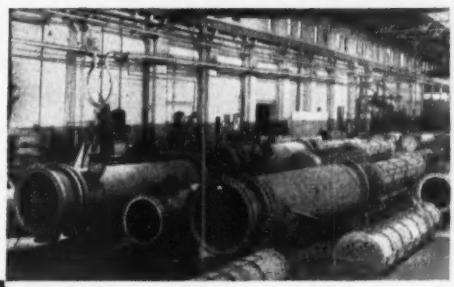
PROCESS EQUIPMENT FOR EVERY SERVICE

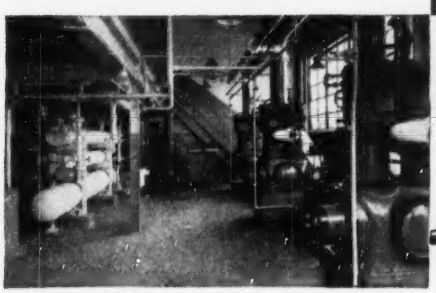
Vogt constructs process equipment in wide variety to all Codes. Stills and towers, oil chillers, crystallizers, heat exchangers, molding machines, etc., serve in the manufacture of oils, greases, 100 octane gasoline, synthetic rubber, chemicals and related products around the world.



SPECIAL MATERIALS COMBAT CORROSION AND PRODUCT CONTAMINATION

Our modern shops produce a wide variety of equipment from special metals and alloys to fight corrosion and product discoloration or contamination. Fabrication procedures insure that corrosion resistant properties of welds will match that of the materials used to construct the equipment.





MORE REFRIGERATION TONNAGE AT LESS COST

More than 70 years of engineering and manufacturing experience is incorporated in Vogt refrigerating and ice making equipment. Absorption Systems, Compression Systems, and Tube-Ice Machines in a wide range of capacities serve industrial and processing plants, and institutions, here and abroad.

Vogt

PRODUCTS

FOR REFINERIES, CHEMICAL PLANTS POWER PLANTS AND PROCESS INDUSTRIES

HENRY VOGT MACHINE CO.
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the NEW L.A. *Line*

by the Louis Allis Co.

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electric motor BUY

A smaller, better power package to meet new NEMA standards

with NEW MODERN STYLING

plus
Improved ventilation
New conduit-box arrangement
New bearing construction
More compact design and better protection
More versatile mounting

Here you have complete use of modern motor materials, design techniques and new manufacturing methods. You also get more power in a smaller package — and clean, streamlined motor styling to add modern appearance to the equipment these new motors drive.

This new styling is completely functional. Ventilating grilles, for example, blend into the general motor design — yet they provide better protection, greater safety, admit more cooling air.

Completely enclosed housing provides protection for the new L.A. line in any mounting position — floor, sidewall, or ceiling.

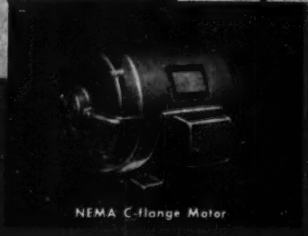
Standardize now on the new L.A. line for both your product and your plant — and get the most modern motor construction available. See your nearby Louis Allis Sales Engineer today for the complete story.

THE LOUIS ALLIS CO.
Milwaukee 7, Wisconsin

LA-102

Vertical NEMA C-flange Motor

NEMA D-flange Motor

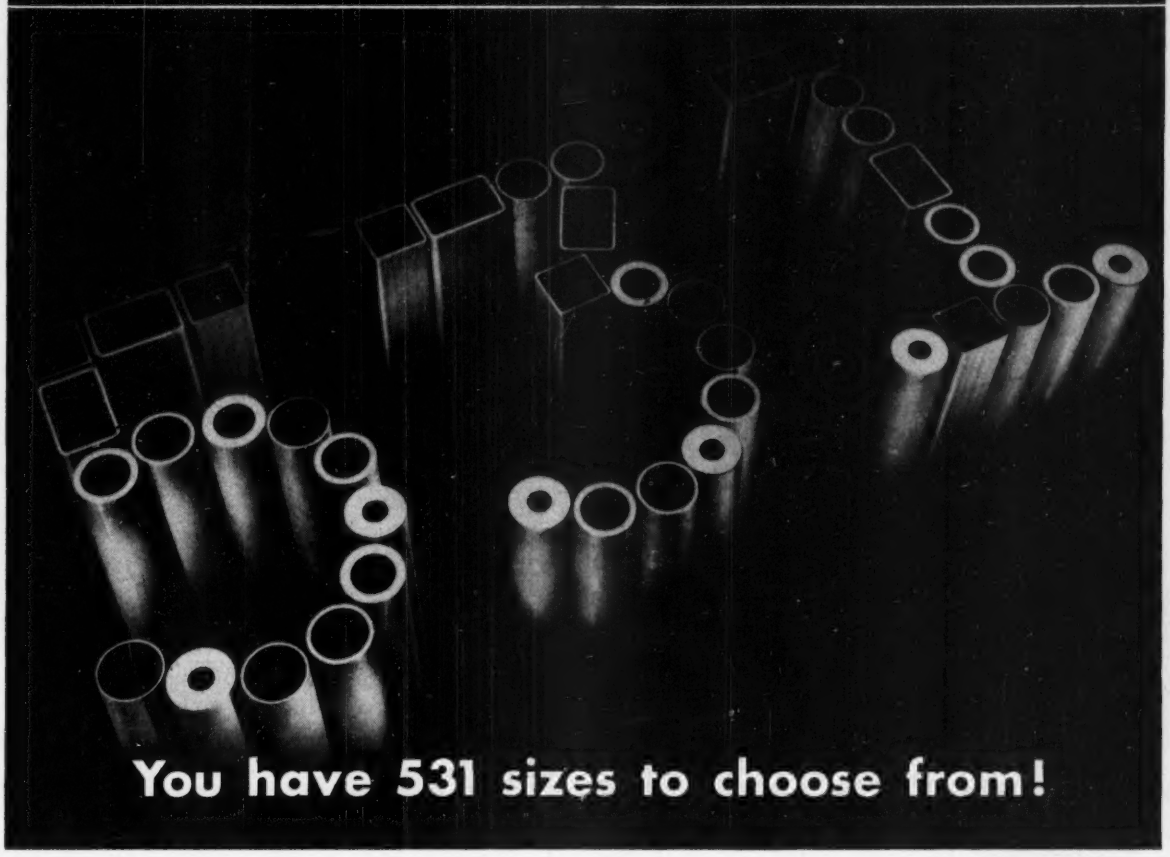


NEMA C-flange Motor

We specialize in SPECIAL MOTORS— *and* PROMPT DELIVERY, TOO

There's a Louis Allis special motor for your engineer application. Whatever electrical or mechanical modifications you need, check first with Louis Allis.

WHY IT PAYS TO BUY MECHANICAL TUBING FROM US



You have 531 sizes to choose from!

WE carry no less than 531 sizes of Shelby Seamless Mechanical Tubing and can fill orders promptly . . . by the inch or by the carload. No matter what your tubing needs, we can supply you with the best for the job — tubing manufactured by the world's leading producer, National Tube Division of United States Steel.

Our experience in the field of tubing applications has often saved large sums of customers' money—for it is sometimes possible to substitute a more economical type of tubing than you had planned to use.

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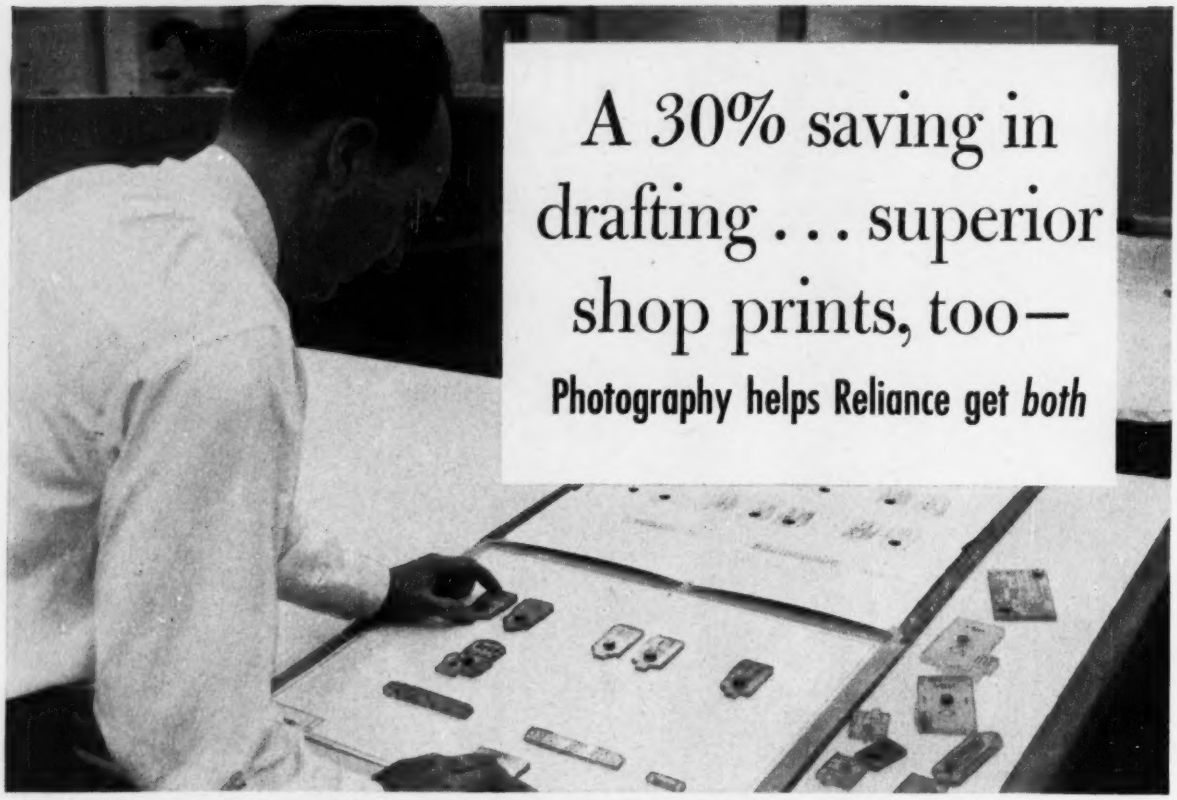
UNITED STATES STEEL



A 30% saving in drafting . . . superior shop prints, too—

Photography helps Reliance get *both*

At the Reliance Electric & Engineering Co., Cleveland, Ohio, the use of photographic templates and Kodagraph Autopositive Paper has helped to lower drafting-room costs by at least 30%, besides assuring highly legible shop prints day in and day out.

The templates—on clear plastic—represent the designs of standard components that appear again and again in Reliance's many wiring diagrams. A draftsman uses them, first, to make a preliminary drawing – positioning the templates he needs on whiteprint paper, making a print, then roughing in the hook-up lines.

After this drawing has been approved, he prints the templates on Kodagraph Autopositive Paper, using a printing frame. Simple photographic processing—under normal roomlight—produces a positive print of the layout directly. All he has to do now is add the hook-up lines, and another drawing is ready for Reliance's file of photo-lasting Autopositive "originals." *Another saving can be chalked up!*

Reliance has found these photo-drawings to be ideal printing intermediates. They're evenly translucent, durable; have crisp, dense black lines. And they produce top-quality shop prints at practical, uniform speeds in Reliance's direct-process machine.

Learn how thousands of companies are simplifying drafting and drawing reproduction routines, and protecting valuable originals with Kodagraph Autopositive Paper. See how you, or your local blueprinter, can process this sensational material quickly, at low cost. Mail coupon today.

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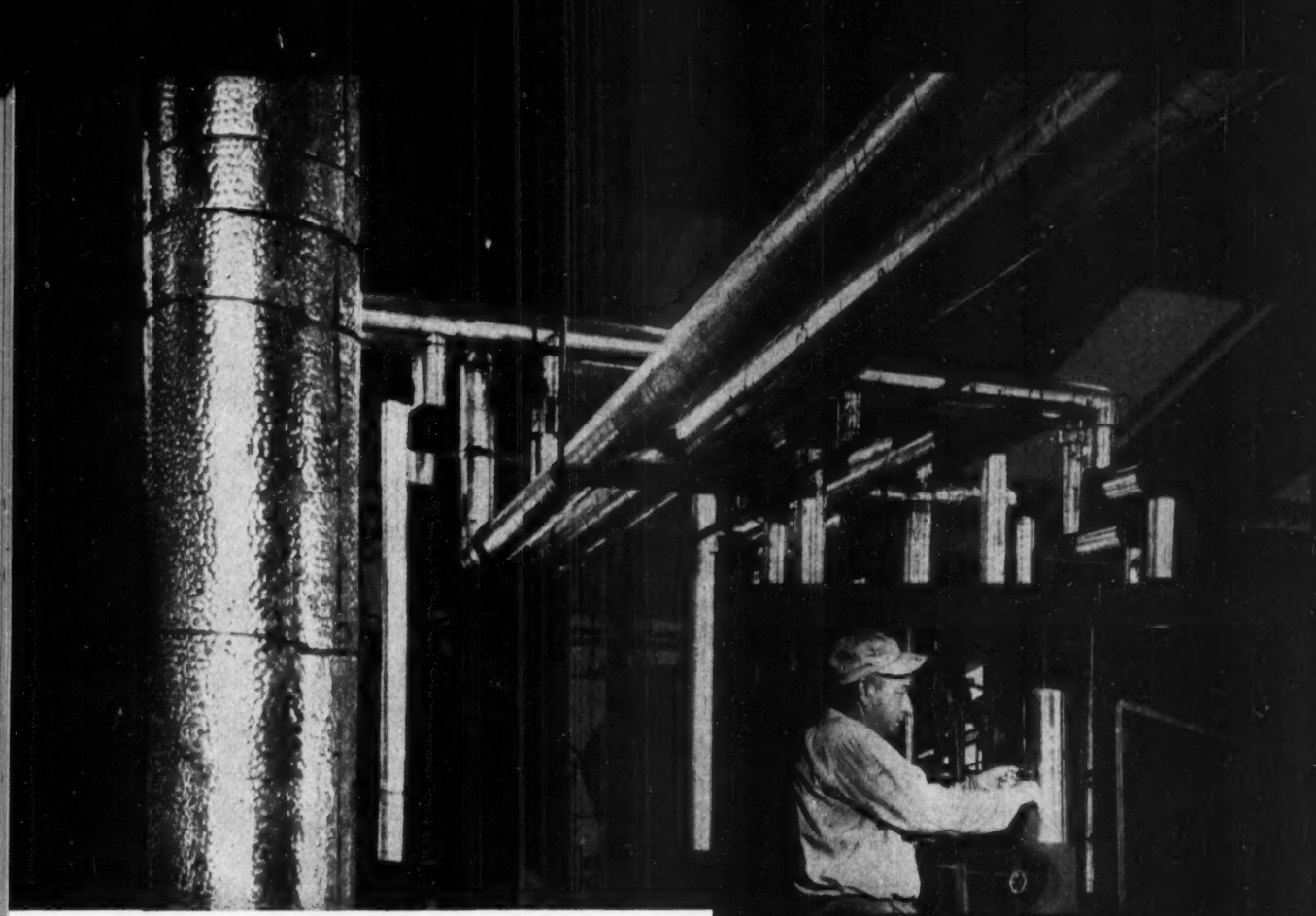
Kodak



GENERAL TIRE & RUBBER COMPANY reports:

"WE SELECTED ALUMINUM-JACKETED FOAMGLAS FOR A PERMANENT, NEAT INSULATION JOB."

From The General Tire & Rubber Company's Baytown (Tex.) Plant comes this news: "In our new polymerization pilot plant FOAMGLAS insulation was installed on brine lines designed to operate at 0° F. Pittsburgh Corning's new *Aluminum*-jacketed FOAMGLAS pipe insulation was selected because we felt it would give us a permanent, serviceable and neat appearing job. We also used FOAMGLAS blocks to insulate vessels operating at 0° F. in this same plant."

You, too, should take advantage of the outstanding insulating performance of FOAMGLAS in *your* plant. For more details, use the coupon.

PITTSBURGH CORNING CORPORATION

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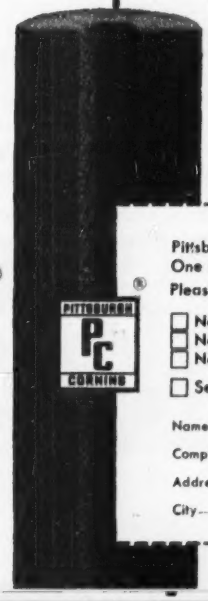
FOAMGLAS®

the cellular glass insulation . . . it stays dry!

Aluminum-jacketed FOAMGLAS offers these advantages:

1. **FASTER, CHEAPER APPLICATION:** factory-jacketed with aluminum, this new FOAMGLAS pipe covering gives you moisture-proof insulation, weatherproof jacket and attractive finish all-in-one.
2. **BEAUTIFUL LOW-COST FINISH:** Aluminum-jacketed FOAMGLAS gives you a most eye-appealing installation without the customary high costs required to give an attractive finish to ordinary insulations and field-applied jackets.
3. **LESS MAINTENANCE:** now the rot-proof, acid-proof qualities of FOAMGLAS are in the finish. The wrinkle-free aluminum surface takes abuse and is weather-resistant, sanitary, easy to clean, saves re-painting expense.
4. **EXTRA INSULATION:** aluminum's heat reflecting asset supplements the unequaled insulating properties of FOAMGLAS . . . the rigid, cellular glass insulation that *stays dry* inherently, retaining its original insulating efficiency.



Pittsburgh Corning Corporation, Dept. H-64
One Gateway Center, Pittsburgh 22, Pa.

Please send me the following brand new FOAMGLAS literature:

- ☐ New bulletin and sample of Aluminum-jacketed FOAMGLAS.
- ☐ New folder on FOAMGLAS pipe insulation.
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- ☐ Send engineer to discuss specific problem.

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Keyed...to your cost problems

One key that solves production and cost problems...that improves plant efficiency...is a fresh viewpoint, a new idea.

There's where the specialized services of your Chain Belt Field Sales Engineer can help you. His broad application knowledge...his familiarity with your problems...and the efficient performance of Chain Belt Products can help you find the right key to your problems.

for example: If "flooding" or "starving" of your belt conveyors is your problem, Rex Apron Feeders can assure that one right "key" to more economical and efficient operation. They closely regulate the flow rates of the material-handling system, substantially reducing costs.

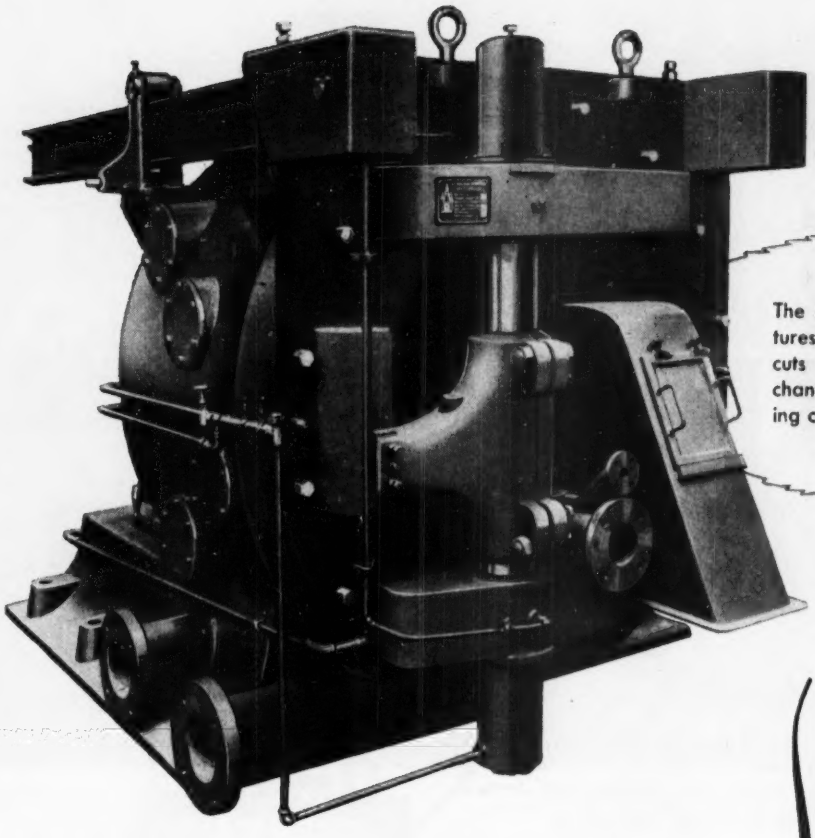
for example: If efficient bucket elevators are your needs, there is a size and type to exactly fit your operations. Rex Conveying Engineers will study your flow rates, materials handled, space requirements and recommend the elevator that will assure most economical operations.

for example: If you're having "belt idler troubles," there's an answer in the complete Rex Idler Line. Impact idlers that cushion loading shocks, self-aligning idlers that lengthen belt life, troughing idlers that cut maintenance costs, are a few of the many that can help you.

Whatever your needs... drive chain, conveyor and elevator chain, complete elevators, belt conveyors, feeders, roller bearings and transmission, buckets or sprockets, you'll relieve those production pains by looking to Chain Belt. See your local Field Sales Engineer or write direct to Chain Belt Company, 4648 W. Greenfield Ave., Milwaukee 1, Wis.

CHAIN BELT COMPANY

District Sales Offices and Distributors in all Principal Cities



The 50" Reineveld Centrifuge features the Roll-Out Front Cover which cuts the "down" time needed for changing of the filter cloth or replacing of a dull cut-out knife.

Consider ALL of these Factors when You Compare Centrifuges

- Initial Cost
- Production Capacity
- Amount of Filtering Surface
- Materials of Construction
- Weight
- Amount of Vibration
- Maintenance Costs
- Quality of Filter Cake
- Ease of Cleaning
- Versatility

COMPARE THE REINEVELD CENTRIFUGE with any other centrifuge of its type . . . on the points listed above or on any other factor you choose.

See for yourself why the Reineveld Centrifuge is your best buy . . . from any angle.

The experienced engineers and complete laboratory facilities of Heyl & Patterson are available to determine the value of a centrifuge in your application and to recommend the most economical and efficient use of centrifugal equipment.

Booklet 6-RC-3 can help you judge the Reineveld Centrifuge for yourself. Write for your copy today.

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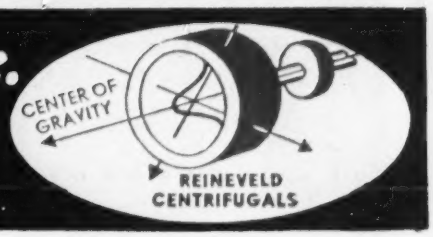

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YOUR INDUSTRY, like so many others, very probably uses brine in its operation.

And now the LIXATE Process, pioneered and developed by the International Salt Company, takes all the complications, all the inaccuracies, all the costly handling out of brine making. You use rock salt—and gravity does all the work.

You just turn a valve and *instantly* you have brine where you need it, when you need it—automatically!

And because this pure brine is *always* 100% saturated, because it *always* contains exactly 2.65 pounds of salt per gallon, your brine measurements are *unfailingly* 100% accurate.

Hundreds of companies have saved thousands of dollars, have improved the quality of their products by installing the LIXATE Process. Let International's Industrial Division help *you*. Send the coupon below, today.

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I am interested in knowing what the *Lixate* Process can do for MY plant. Please have an International Industrial Engineer contact me as soon as possible. I understand there is no cost, no obligation.

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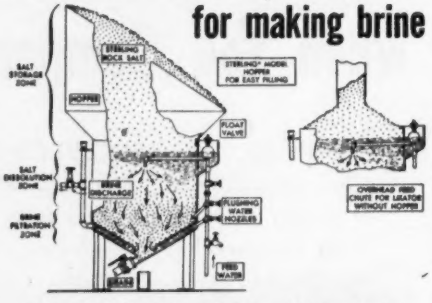
MY TITLE_____

the LIXATE* process for making brine



HOW LIXATOR WORKS

In the dissolution zone—flowing through a bed of Sterling Rock Salt which is continuously replenished by gravity feed, water dissolves salt to form 100% saturated brine. **In the filtration zone**—through use of the *self-filtration* principle *originated by International Salt Company*, the saturated brine is thoroughly filtered through a bed of *un*dissolved rock salt. The rock salt itself filters the brine. Nothing else is needed.

INTERNATIONAL SALT CO., INC.
SCRANTON, PENNSYLVANIA

SALES OFFICES: Atlanta, Ga. • Chicago, Ill. New Orleans, La. • Boston, Mass. • St. Louis, Mo. Newark, N. J. • Buffalo, N. Y. • New York, N. Y. Cincinnati, O. • Philadelphia, Pa. • Pittsburgh, Pa. Richmond, Va. • ENGINEERING OFFICES: Atlanta, Ga. Chicago, Ill. • Buffalo, N. Y. *Reg. U. S. Pat. Off.

MODERN EQUIPMENT and closest attention to every casting detail enable new Aloyco foundry to turn out the finest corrosion-resistant valve castings made.

New Aloyco foundry helps process industries in record expansion

PATTERN SHOP. In this well-equipped shop seasoned craftsmen make extremely accurate wood or metal patterns for valves of any size or complexity.

During 1954, almost half the nation's total investment in new plants and equipment will go into the chemical and petroleum industries.

To meet their unprecedented needs for processing equipment, our new specially-equipped foundry will substantially increase the production of Aloyco corrosion-resistant valves.

For 25 years, Aloyco, the world's largest specialist in high alloy valves, has been helping the chemical process industries master valve corrosion problems. Alloy Steel Products Co., Inc., 1301 West Elizabeth Avenue, Linden, New Jersey.

Plants: Linden, N. J., Bloomfield, N. J., Elizabeth, N. J.

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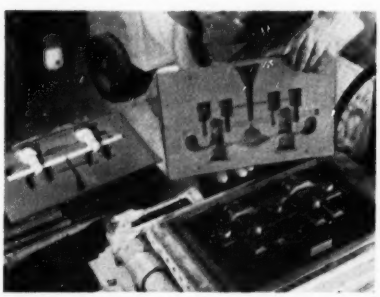
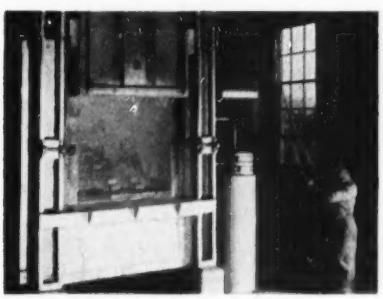
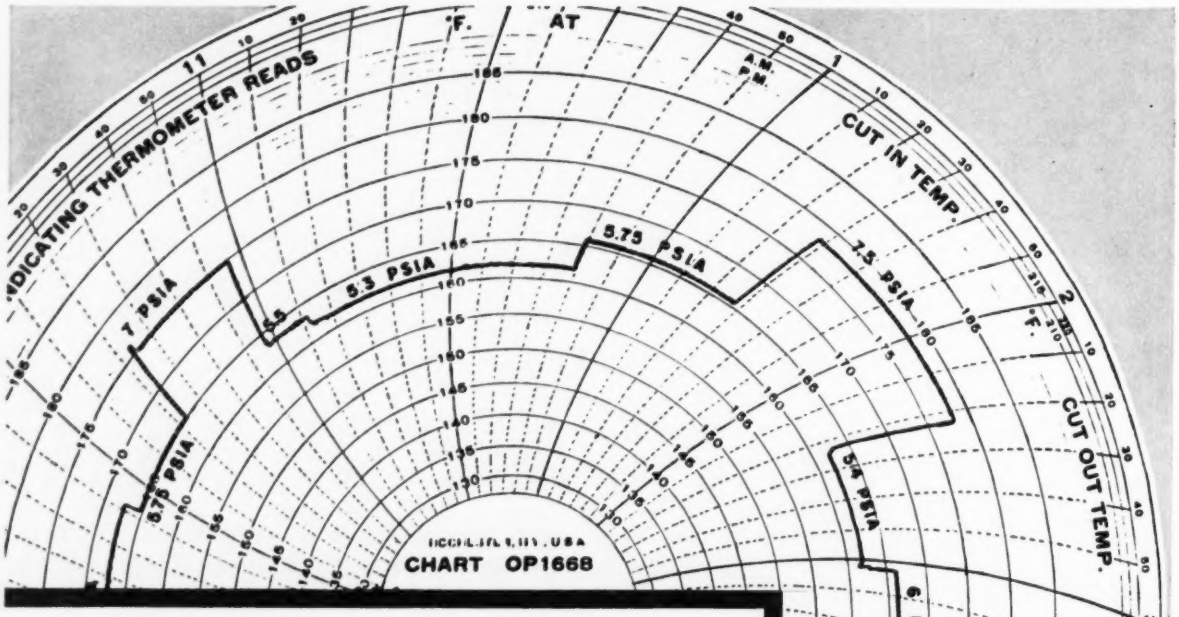


SHELL MOLDING. Up-to-date shell molding facilities assure users of the greatest contour accuracy in castings for small and medium-sized Aloyco valves.

INSPECTION AND HEAT STAMPING. Castings are carefully inspected, their "pedigrees" stamped in. Any not 100% perfect are remelted, never welded or patched.



HEAT TREATING. After cleaning, all Aloyco austenitic type castings are heat treated and water quenched to insure maximum corrosion resistance.



SEE WHAT A HEAT EXCHANGER *CAN* DO... *WHEN IT'S A DE LAVAL!*

This chart, made under normal operating conditions, shows the temperature of the heated product of a De Laval Plate Heat Exchanger, using the De Laval Vacuum-Steam Heating System, in which temperature is controlled by the amount of vacuum (shown on the chart in psia) applied to the steam in the heating section.

Note these two outstanding features:

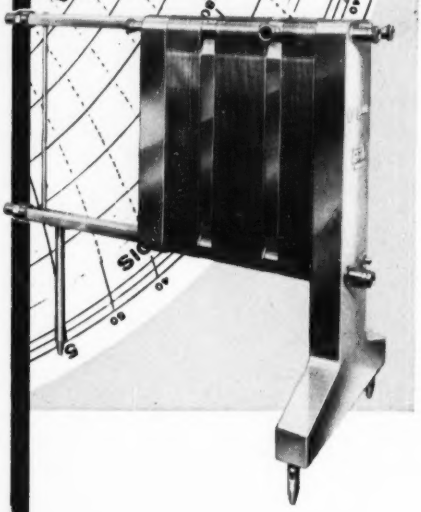
(1) The *straightness* of the lines at the various temperatures—lines which, while straight, have "life" in them, indicating the sensitivity of the instruments . . . (2) The *immediate* and *sharp* response to each demand for a temperature change. Quite obviously there is no "seeking" for the correct temperature.

Here is proof that the De Laval Plate Heat Exchanger and the De Laval Vacuum-Steam Heating System, together, provide a simple method for accurate control of product temperature with instant response to any change in operating requirements.

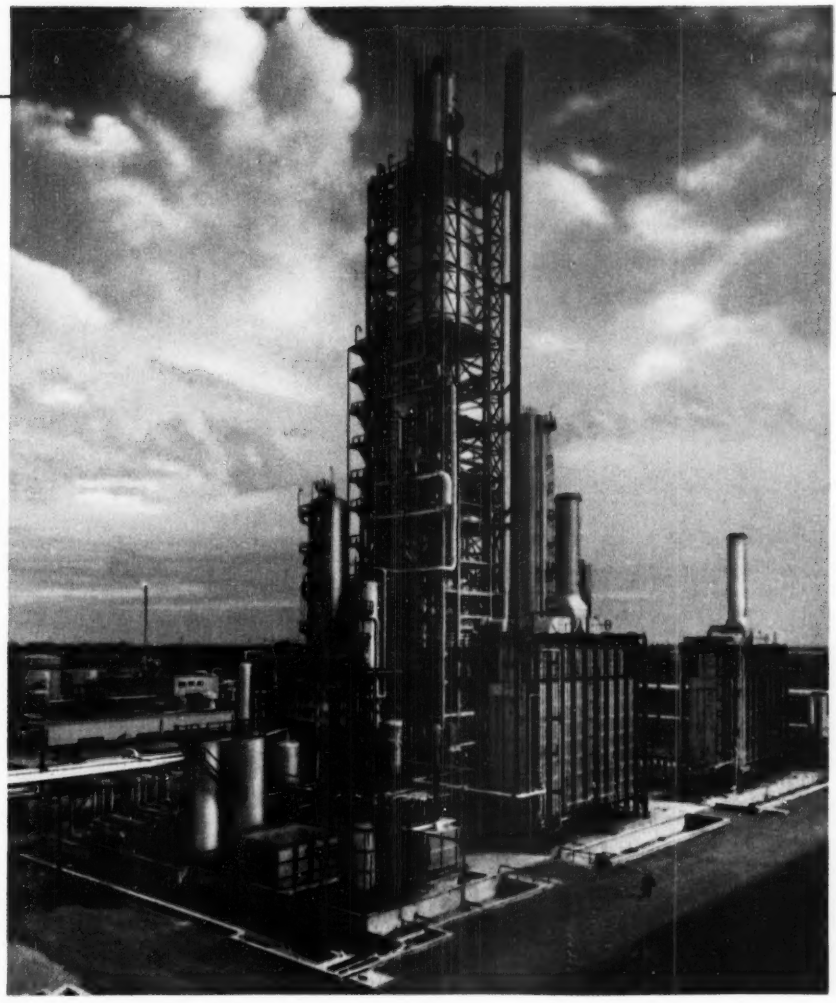
For complete technical information regarding De Laval Plate Heat Exchangers for heating, cooling or regeneration . . .

Write for De Laval's Bulletin PHX.

THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York ● 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5



DE LAVAL
PLATE HEAT EXCHANGERS



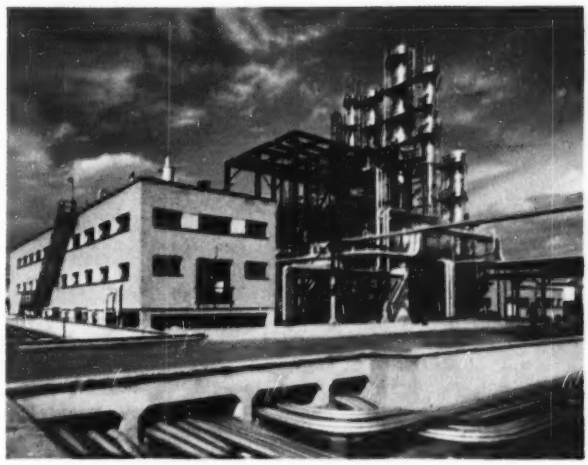
The new Condor catalytic cracking unit has a capacity of 15,000 barrels per day. The crude unit in the background has a capacity of approximately 45,000 barrels. Condor's new gas plant and compressor building are shown below.

Condor-AT RHO, NEAR MILAN

Located in the Po River Valley, and advantageously situated in relation to Italy's fine Autostrade highway system, "Condor S.p.A. L'Industria Petrolifera e Chimica," exemplifies the regeneration of Western Europe's essential industries.

The basic engineering for Condor's petroleum refinery process units was performed in the United States by Stone & Webster Engineering Corporation, with detailed engineering, procurement, and construction management by the Corporation's affiliate, E. B. Badger & Sons Limited.

Write or call us for information as to how our experience may be of assistance to you.



STONE & WEBSTER ENGINEERING CORPORATION

BADGER PROCESS DIVISION

AFFILIATED WITH E. B. BADGER & SONS LIMITED (LONDON)

New York Boston Chicago Pittsburgh Houston San Francisco Los Angeles Toronto

How would YOU solve these two problems?

1. A PATCH AHEAD OF TIME, applied at the factory, reinforces the knees of dungarees and overalls. Patches are vulcanized under pressure with Radio Frequency Corp.'s high frequency, dielectric heater. If dielectric heat, generated in the material, is lost through conduction, vulcanization becomes inefficient. But Fenwal THERMOSWITCH® units in each platen minimize these losses by close temperature control. Vulcanizing 3000 patches per hour is now standard; 30 was.

2. DENTAL PLATE FIT STARTS WAY BACK. The tiny abrasive wheels for grinding and polishing dental plates must be very accurately molded of fine abrasive in a rubber base. The molds in which they're made must have delicate temperature control for consistent quality and uniformity. The manufacturer, The Wm. R. Hall & Son Co., uses THERMOSWITCH units in molds for accurate, reliable temperature control. Production figures can be kept high while rejects are low.

3. THIS IS IT — the Fenwal THERMOSWITCH control is simple — compact shell contracts or expands *instantly* with temperature changes, opening or closing electrical contacts. Adjustable and highly resistant to shock and vibration. Fenwal THERMOSWITCH units are solving temperature problems and helping to improve the final product throughout all industry.

4. SEND FOR THIS BROCHURE for complete explanation of the unique THERMOSWITCH unit. Also ask for more detailed, illustrated discussions of the problems above. Fenwal engineers will be glad to help you solve your temperature control problems involving heat, humidity, radiant heat, pressure and other variables. Write Fenwal Incorporated, 168 Pleasant St., Ashland, Massachusetts.

Fenwal

THERMOSWITCH®

Electric Temperature Control and Detection Devices

SENSITIVE... *but only to heat*

CROUSE-HINDS

Explosion-Proof
LIGHTING FIXTURES

Hazardous areas in this plant are lighted by Crouse-Hinds EV Series Explosion-Proof and Raintight Lighting Fixtures

. . . EXCEED the requirements for service in highly explosive atmospheres

To be safe for use in such locations, the fixture must operate at a temperature below the ignition temperature of the gas-air or vapor-air mixture. Also, the fixture must be so strong that it will resist internal explosions without damage and so tight that it will prevent the escape of flames or burning gases which might ignite the surrounding atmosphere.

Crouse-Hinds EV Series explosion-proof and raintight industrial lighting fixtures meet all of these requirements PLUS a wide margin of safety for extra protection.

Complete listings are in Crouse-Hinds Condulet Catalog.

Crouse-Hinds offers a complete line of explosion-proof and dust-tight lighting fixtures for use in hazardous locations where fluorescent lamps are desired.

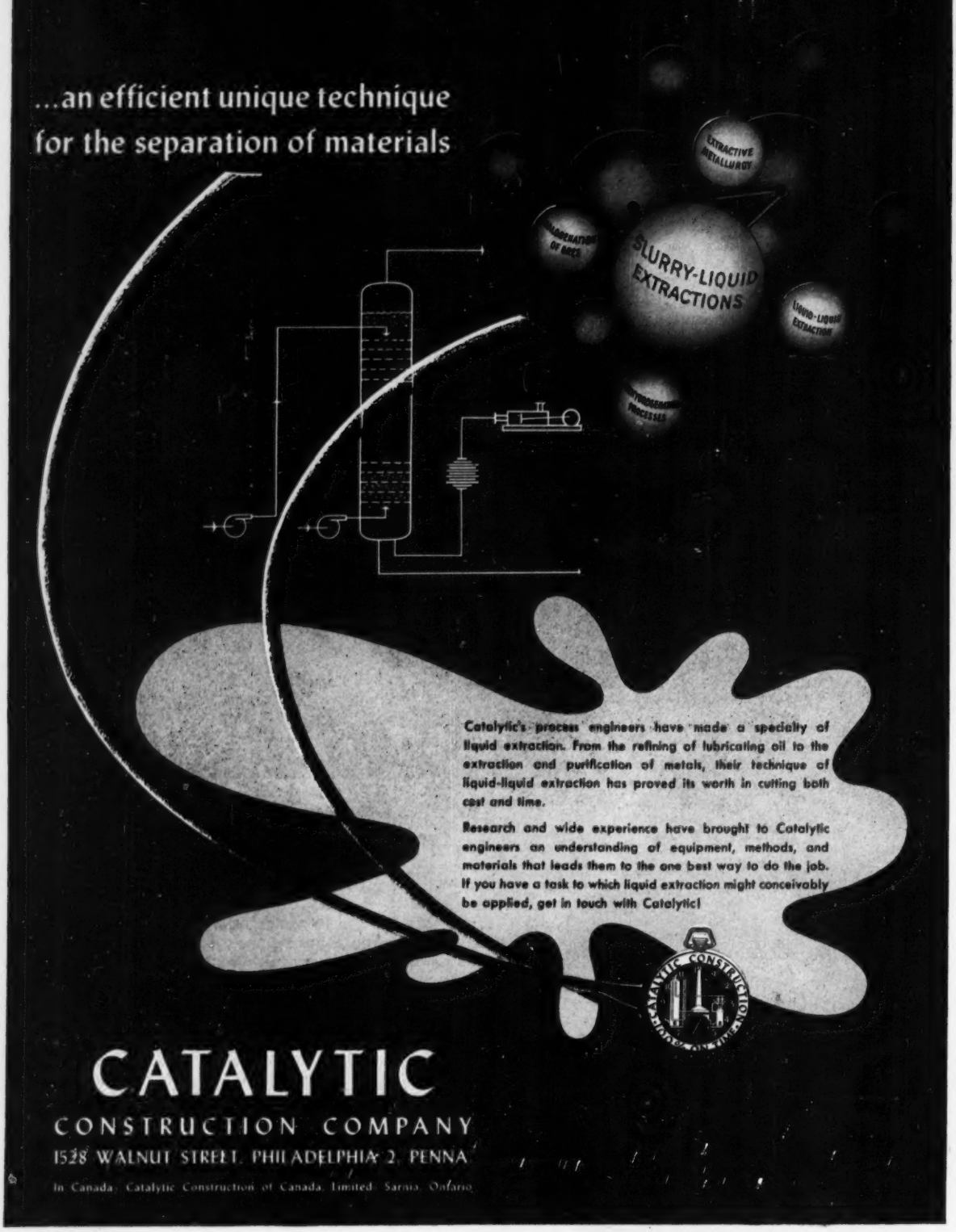
CROUSE-HINDS COMPANY
Syracuse 1, N. Y.

OFFICES: Birmingham — Boston — Buffalo — Chicago — Cincinnati — Cleveland — Dallas — Denver Detroit — Houston — Indianapolis — Kansas City — Los Angeles — Milwaukee — Minneapolis New Orleans — New York — Philadelphia — Pittsburgh — Portland, Ore. — San Francisco — Seattle St. Louis — Tulsa — Washington RESIDENT REPRESENTATIVES Albany — Atlanta Baltimore — Charlotte — Corpus Christi — Richmond, Va. — Shreveport Crouse-Hinds Company of Canada, Ltd. Toronto, Ont.

A Nationwide Distribution Through Electrical Wholesalers

CONDULETS · TRAFFIC SIGNALS · AIRPORT LIGHTING · FLOODLIGHTS

...an efficient unique technique
for the separation of materials

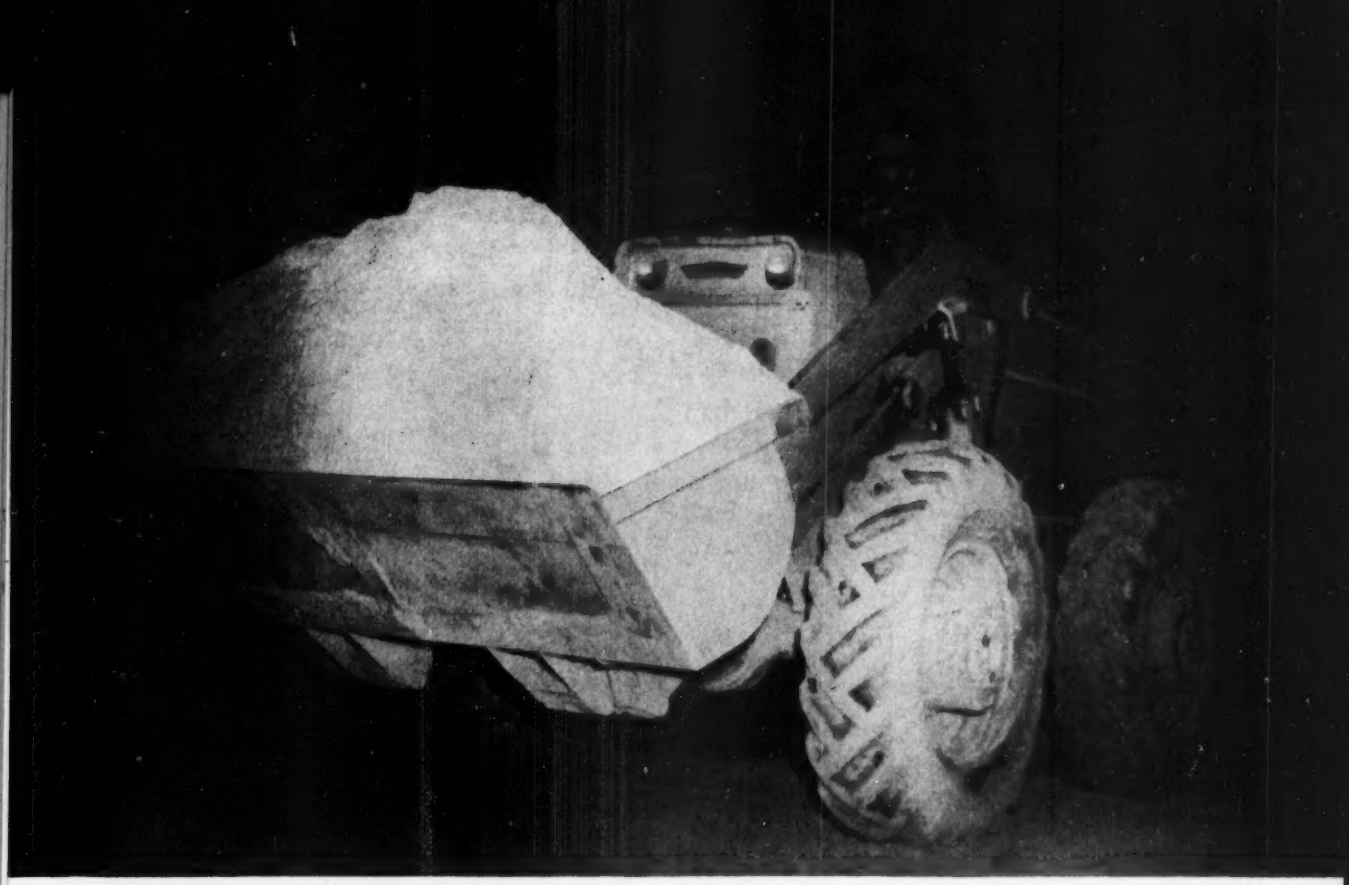


Catalytic's process engineers have made a specialty of liquid extraction. From the refining of lubricating oil to the extraction and purification of metals, their technique of liquid-liquid extraction has proved its worth in cutting both cost and time.

Research and wide experience have brought to Catalytic engineers an understanding of equipment, methods, and materials that leads them to the one best way to do the job. If you have a task to which liquid extraction might conceivably be applied, get in touch with Catalytic!

CATALYTIC
CONSTRUCTION COMPANY
1528 WALNUT STREET, PHILADELPHIA 2, PENNA.
In Canada: Catalytic Construction of Canada, Limited, Sarnia, Ontario

CATALYTIC *ON-TIME... ON-BUDGET* SERVICES for the atomic energy, chemical, petrochemical and oil refining industries
Process Design Project Analysis Economic Studies Engineering Procurement Construction Plant Operation



MICHIGAN *bucket control means "Bigger Loads . . . . . FASTER"*

Watch a MICHIGAN Tractor Shovel at work —with particular attention to bucket action —and you'll *see* how a MICHIGAN* will *handle bigger loads, move more yardage*—faster, at considerably lower cost.

- *Tremendous break-out power*—ram the cutting edge into any tough, hard-to-dig clay, shale or loose rock—and *work the bucket* to loosen it
- *Bucket roll-back at ground level*—pick up and transport full buckets at low center of gravity for safe traveling, no void space in the bucket; more work in less time
- *Remarkable digging ability*—two large double acting cylinders on bucket and two large double acting cylinders on main lift give excellent control and superior digging action.
- *Good bucket height and reach*—high dumping clearance and ample forward reach make trucks easy to load.

Check these outstanding Quality Features of MICHIGAN* Tractor Shovels . . .

1. Superior Bucket Action—bigger loads, faster loading

2. Clark Power-Shift Transmission—faster operating cycle gets more yardage

3. Clark Torque Converter—3-to-1 torque multiplication; *power when needed*—no conventional clutch

4. Clark Planetary Axle—relieves torque load on shafts and gears, prolongs machine life

5. Power Steering—much easier handling, lessens driver fatigue

6. Gas or Diesel—right power for the job; more horsepower than any comparable machine

Six models: capacities from 1 5 cubic feet to 2¼ cubic yards. Facts about the MICHIGAN Tractor Shovel are important—and interesting. The MICHIGAN Fact Folio contains specifications and action photos. The coupon gets it for you.

*A Trademark of Clark Equipment Company

CLARK EQUIPMENT

16A

CLARK EQUIPMENT COMPANY
Construction Machinery Division
432 Second Street, Benton Harbor, Michigan

Please send the MICHIGAN Tractor Shovel Fact Folio

Name_____ Title_____

Firm_____

Address_____

City_____ County_____ State_____

Case No. 58

Results Bring Re-Order from Heyden Chemical Corp. for Second Kemp Inert Gas Generator

Heyden Chemical doubles its blanketing savings with Second Kemp Generator

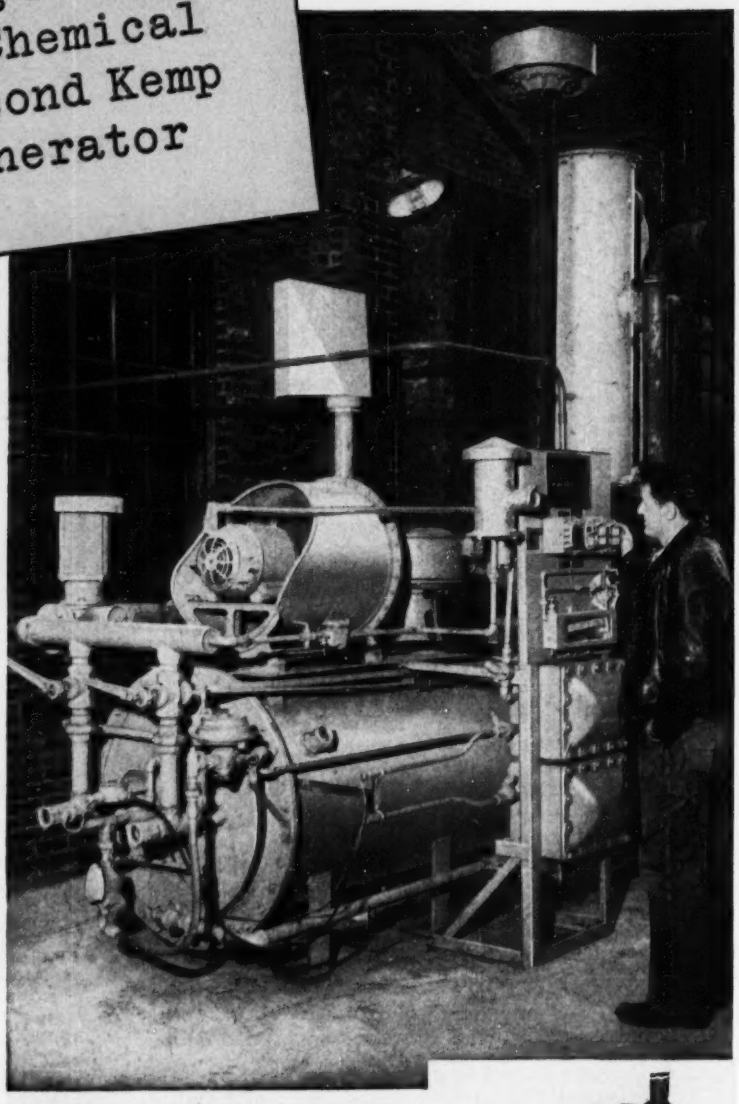
HERE'S A CASE where simple mathematics paid big dividends at this Garfield, New Jersey plant. When Heyden Chemical—one of the nation's leading producers of formaldehyde, pentaerythritol, salicylic acid, etc.—installed its first Kemp Inert Gas Generator to furnish CO_2 for blanketing a special grinding operation, it was on more or less a test basis. Part of Heyden's constant search for newer, better, cheaper ways to improve its products. The rest of its blanketing needs were still being handled with CO_2 from large storage tanks in the plant.

Immediate Savings with Kemp

Results with the first Kemp Inert Producer were impressive. Now a second (see right) Kemp unit has been installed and actual savings over previous costs are estimated at over $500 a month for the first year. In addition to dollars saved, Kemp Generators assure a safe, dependable supply of chemically clean inerts. Deliver inerts at a special analysis . . . without fluctuations.

Kemp Designs Versatile

If you still rely on old-fashioned inert sources or are dissatisfied with present inert equipment, let Kemp help you, too. Kemp Engineers will be most happy to help solve your inert problems . . . show you how you can get similar results with fast-starting, easy-to-operate Kemp Generators. It costs you nothing to investigate. And it may save you real money.



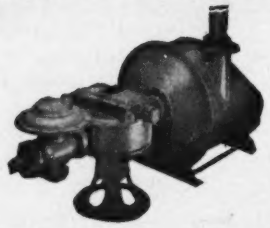
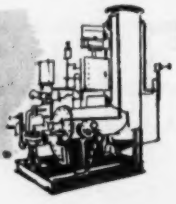


Photo at right shows close-up view of Kemp Industrial Carburetor. Part of every Kemp installation, it eliminates tinkering, waste. Assures complete combustion at all times. Reduces installation costs and maintenance.

For more complete facts and technical information, write for Bulletin I-10 to:
C. M. KEMP MFG. CO., 405 East Oliver Street, Baltimore 2, Maryland.

KEMP OF BALTIMORE

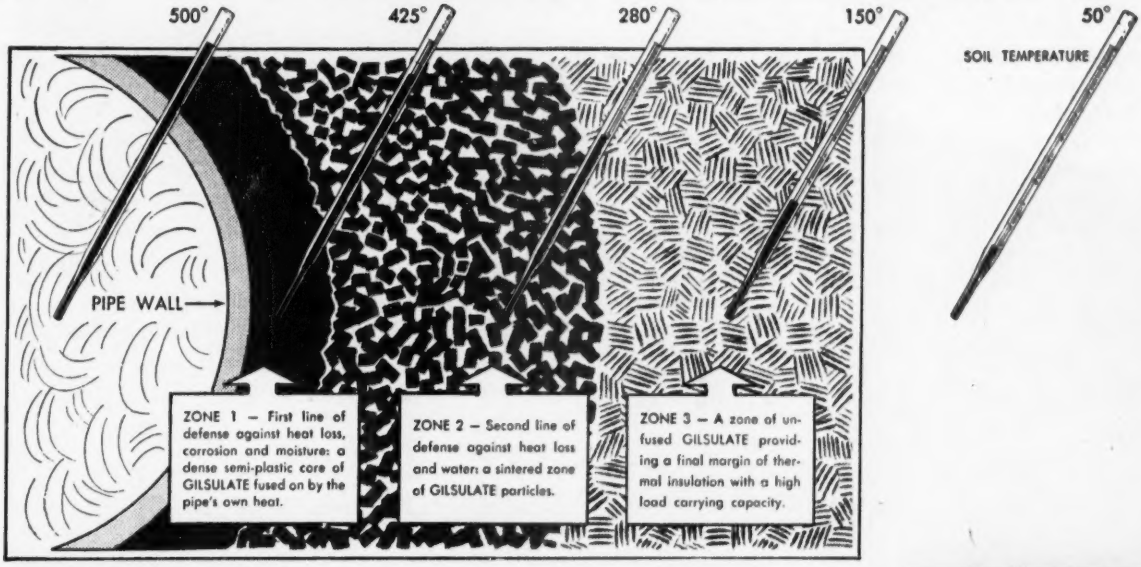


INERT GAS GENERATORS

CARBURETORS • BURNERS • FIRE CHECKS
METAL MELTING UNITS • ADSORPTIVE
DRYERS • SINGEING EQUIPMENT

Lowest Cost

PER INSTALLED LINEAR FOOT OF ANY HOT UNDERGROUND PIPE INSULATION


500°
425°
280°
150°
50°
SOIL TEMPERATURE
PIPE WALL
ZONE 1 – First line of defense against heat loss, corrosion and moisture: a dense semi-plastic core of GILSULATE fused on by the pipe's own heat.
ZONE 2 – Second line of defense against heat loss and water: a sintered zone of GILSULATE particles.
ZONE 3 – A zone of unfused GILSULATE providing a final margin of thermal insulation with a high load carrying capacity.

GILSULATE®... the triple-zone insulation that fuses itself into lifetime protection for hot underground pipes. Water-proof, corrosion-proof, root-proof, acid/alkali-proof.

Compare your present insulation methods with Gilsulation:

1. Pour Gilsulate granules out of the bag onto the pipe; tamp it down.
2. Backfill: *the job is insulated!*

Gilsulate—nature's own insulation—is a unique, solidified hydrocarbon that virtually installs itself. Normal pipe-heat (up to 520°F) does the rest—fuses the Gilsulate to the pipe in hours, forming a massive circular solidified sheath.

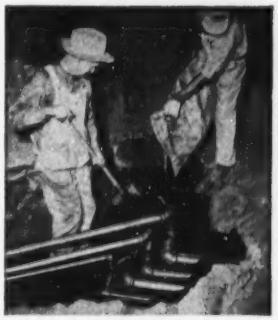
Gilsulate costs less installed per linear foot *than any other underground pipe insulation*... it's easiest to use... and has been tested in scores of the country's largest and most important installations.

Some additional Gilsulate advantages:

- *3 grades available*—220° to 520° F
- *needs no sleeves* or mechanical sheaths
- *requires no mixing* or special handling
- *can't be punctured* – leave rocks in backfill
- *pipe expands and contracts* within Gilsulate structure
- *proved in actual use* in hundreds of new construction and replacement installations

Send coupon for descriptive literature.

AMERICAN GILSONITE COMPANY
SALT LAKE CITY, UTAH
Affiliate of Barber Oil Corp. & Standard Oil Co. of California



No skills necessary—simply pour Gilsulate out of 100 pound bags, tamp and backfill. Can be used under any and all conditions—no matter how many pipes, whatever the space.

GILSULATE®

THE TRIPLE-ZONE INSULATION
FOR LIFETIME PROTECTION
OF HOT UNDERGROUND PIPES.

American Gilsonite Company
134 West Broadway, Salt Lake City 1, Utah
or 1145 East Jersey Street, Elizabeth 4, N. J.

Please send me descriptive literature on Gilsulate.

NAME .....

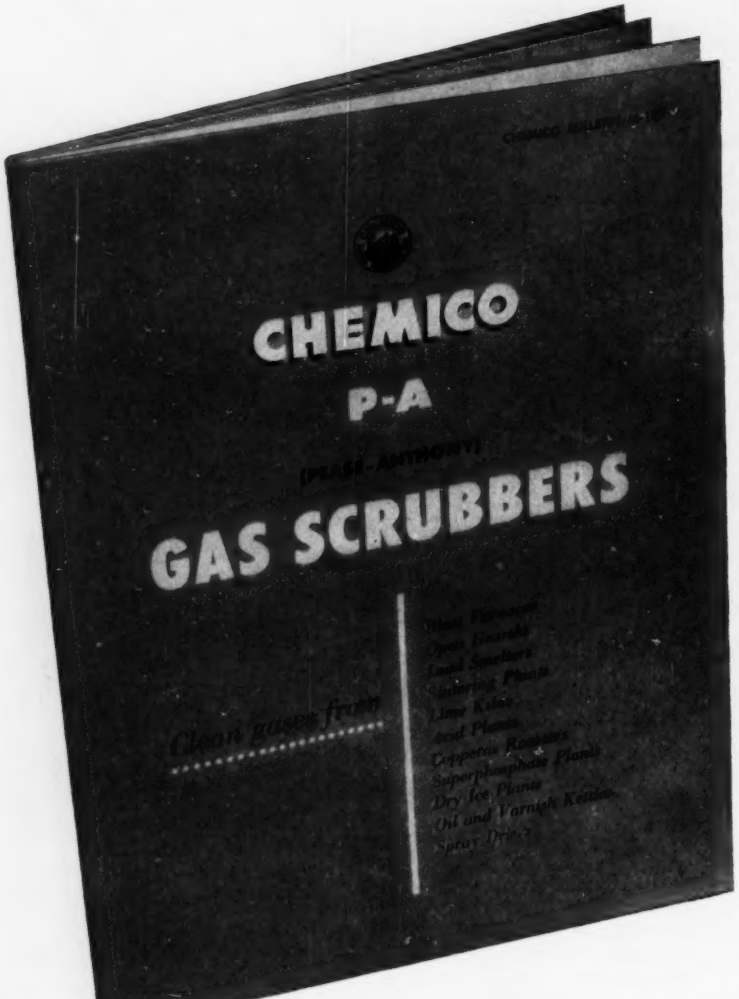
TITLE .....

COMPANY .....

ADDRESS .....

CE

High Gas Scrubbing Efficiency
AT LOW COST!



This Chemico bulletin contains factual information on the two types of Chemico P-A Gas Scrubbers. Both scrubbers offer high collection efficiency at low cost. Both are now being successfully used in a wide range of industries.

The bulletin gives performance data on the *P-A Venturi Scrubber* that effectively and economically removes sub-micron dusts, fumes and mists from industrial gases, and the *P-A Cyclonic Scrubber* for the removal of micron-size dusts from gas streams. If you have a gas scrubbing problem, write us detailing your specific requirements.

Phone (MU 8-7400) or write our P-A Sales Dept. for further information and ask for our Bulletin M-102 on P-A Gas Scrubbers.

CHEMICAL CONSTRUCTION CORPORATION

A UNIT OF AMERICAN CYANAMID COMPANY

488 MADISON AVENUE, NEW YORK 22, N. Y.

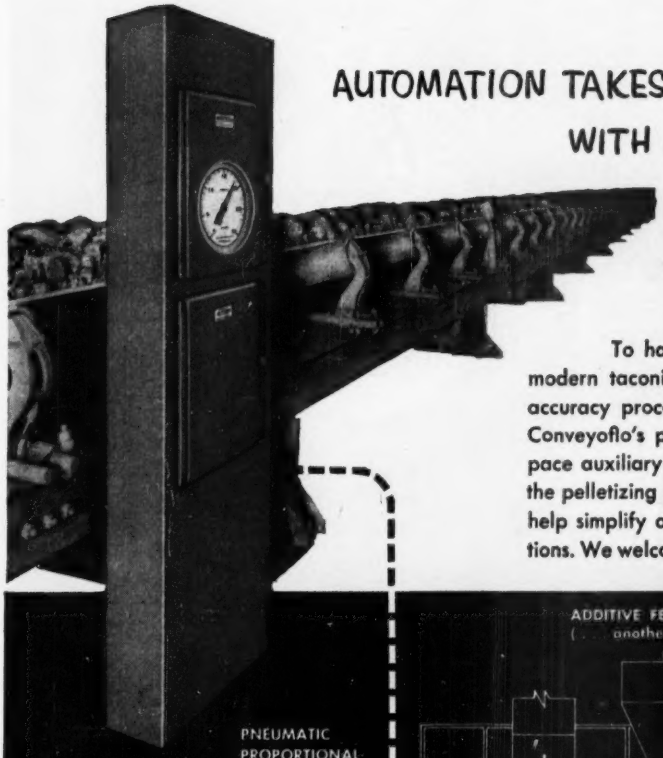
Technical Representatives Throughout the World • Cables: Chemiconst, New York.

DD 884

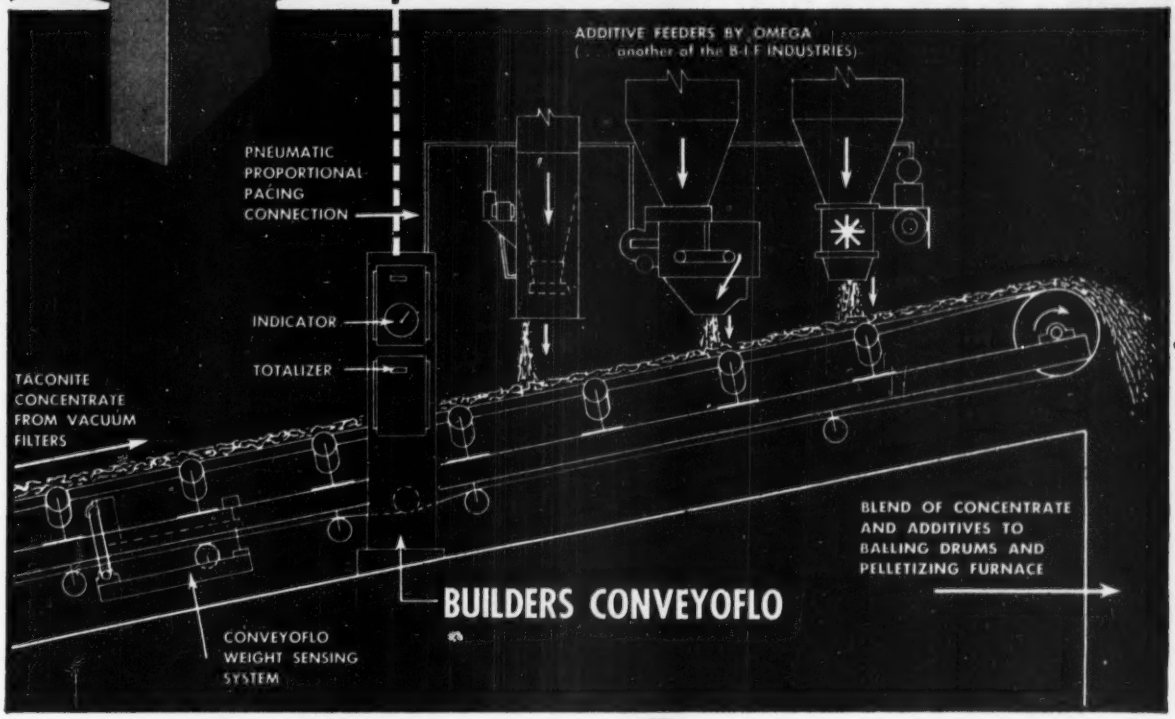
Chemico plants are profitable investments

AUTOMATION TAKES OVER TACONITE PROCESSING

WITH . . . **BUILDERS CONVEYOFLO**



To handle the millions of tons of ore processed in the modern taconite plant requires the latest in high-speed, high-accuracy processing equipment. See in this flow diagram how Conveyoflo's pneumatic weight sensing system is ready-built to pace auxiliary additive feeders to produce the proper blend for the pelletizing process. Then see for yourself how Conveyoflo can help simplify and systematize your continuous processing operations. We welcome your inquiry.


ADDITIVE FEEDERS BY OMEGA
(another of the B-I-F INDUSTRIES)
PNEUMATIC PROPORTIONAL PACING CONNECTION
INDICATOR
TOTALIZER
TACONITE CONCENTRATE FROM VACUUM FILTERS
BLEND OF CONCENTRATE AND ADDITIVES TO BALLING DRUMS AND PELLETIZING FURNACE
BUILDERS CONVEYOFLO
CONVEYOFLO WEIGHT SENSING SYSTEM

CONVEYOFLO FEATURES

- **ACCURATE** . . . within ± ½ of 1% of actual weight from maximum to 50% of rated capacity; within 1% from 50% to 25% rate; within 2% from 25% to 10% of meter's rated capacity.
- **COMPACT** . . . weight sensing mechanism completely contained within conveyor structure. No overhead levers. Panel stand only 9" x 18" — may be any height.
- **AUTOMATIC TOTALIZER COMPENSATION** for variations in belt speed and changes in belt weight.
- **RESPONDS ACCURATELY** to rapid load variations.
- **PACES AUXILIARY EQUIPMENT** (feeders, controllers, continuous blending processes, etc.) and operates secondary totalizers, indicators, recorders.

BUILDERS-PROVIDENCE
DIVISION OF B-I-F INDUSTRIES, INC.
METERS FEEDERS CONTROLS

Builders-Providence, Inc.
369 Harris Ave., Providence 1, R. I.

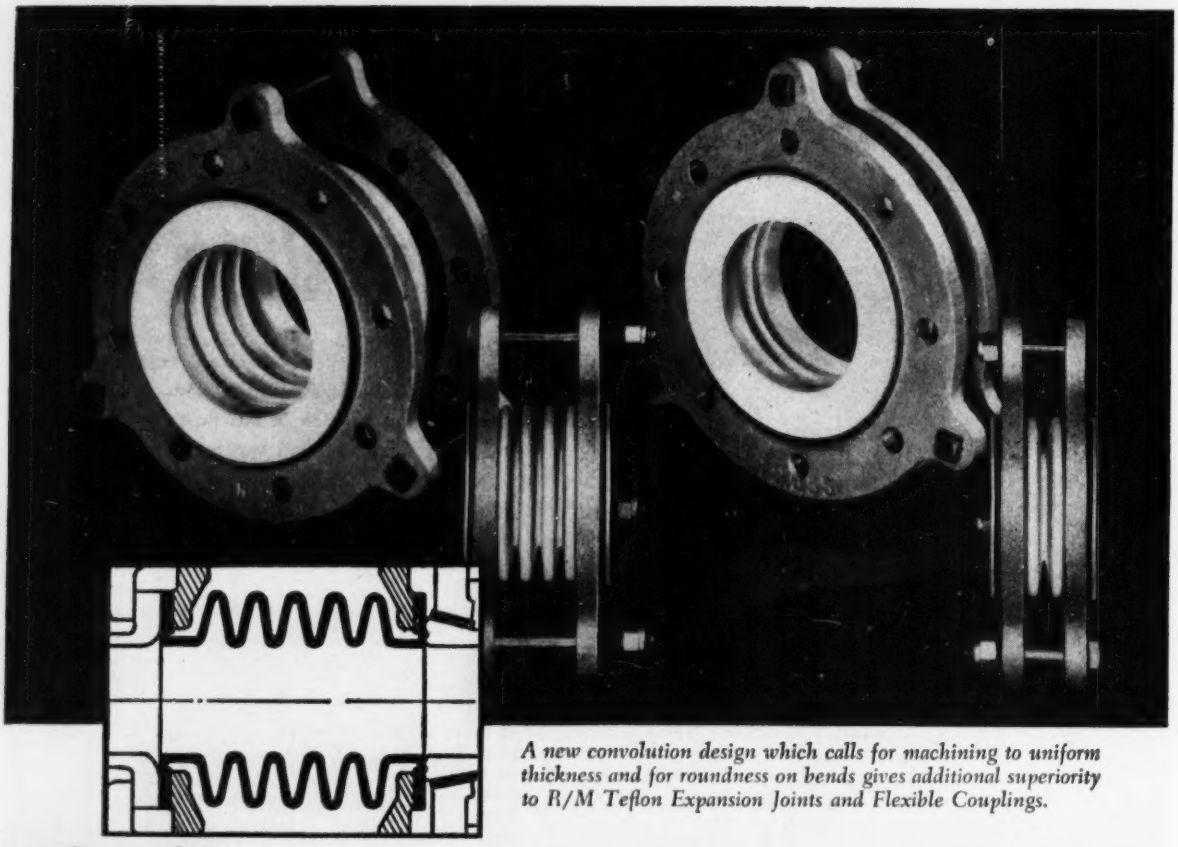
Please send Bulletin 550-H4A describing Builders Conveyoflo Meter

Name .....

Company .....

Street .....

City ..... State .....



A new convolution design which calls for machining to uniform thickness and for roundness on bends gives additional superiority to R/M Teflon Expansion Joints and Flexible Couplings.

R/M Teflon* makes chemically impervious expansion joints and flexible couplings

Whatever your chemical connection requirements are, you can rest assured that R/M Teflon Expansion Joints and Flexible Couplings will meet your needs. R/M Teflon is ideal for such connections because it shows no reaction against chemicals. It is unaffected by any known industrial acids and caustics; it has no known solvent; its water absorption is zero, and weather does not affect it.

One outstanding construction feature of these R/M Teflon connections is the convolution design diagrammed above. The R/M design enables the joints and couplings to absorb greater shock and vibration. Another is the special tie rod arrangement which prevents overexpansion of joints and bending of pipes.

Protect your costly piping and equipment with R/M Teflon Expansion Joints and Flexible Couplings. See your R/M distributor for full details. The complete R/M Teflon products line includes rods, sheets, tubes, tape, packings, gaskets, rings, and irregular shapes.

**Du Pont's trade-mark for its tetrafluoroethylene resin*

R/M MAKES A COMPLETE LINE OF PACKINGS AND GASKETS AND SELLS THEM ONLY THROUGH AUTHORIZED DISTRIBUTORS

R/M PACKINGS
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, MANHEIM, PA.

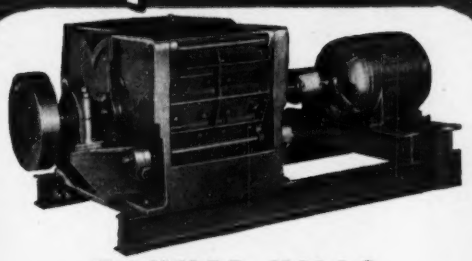
FACTORIES: Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada.

RAYBESTOS-MANHATTAN, INC., Packings • Asbestos Textiles • Industrial Rubber, Engineered Plastic, and Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Bowling Balls

Crush It! Grind It Separate It

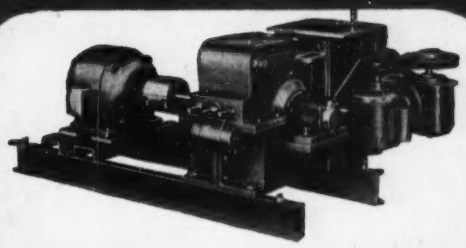
Do It Better, Faster And At Less Cost With...

WILLIAMS



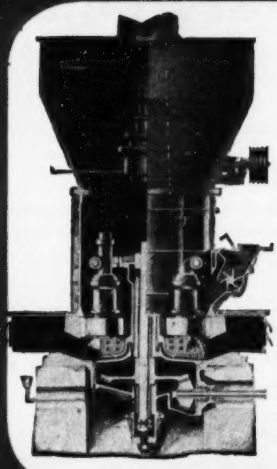
HAMMER MILLS

For heavy duty crushing or grinding of virtually any mineral or chemical—Williams builds them to do *a complete job in one operation!* Primary and secondary crushers are unnecessary—extra foundations, conveyors, other equipment are eliminated! You can save up to 75% on initial investment—up to 50% on grinding costs with the right Williams Hammer Mill!



HELIX-SEAL HAMMER MILLS

For cleaner, safer dustless grinding of dry materials—or non-clogging, accurate grinding of wet, sticky or greasy materials—to finenesses of 100 to 325 mesh. Combines the advantages of a hammer mill with closed-circuit screw-type feed. No separators, fans or cyclones required. Available with steam or water jackets. Low investment—inexpensive to install and operate.



ROLLER MILLS

WITH AIR SEPARATION

For accurate, uniform pulverizing or blending. Instantly adjustable to finenesses down to 400 mesh, even micron sizes. Dries and grinds simultaneously. Automatic, self-adjusting feed. Many other exclusive engineering and construction features. Williams Roller Mills have set new standards for product quality, output and economy.

OTHER WILLIAMS EQUIPMENT

IMPACT and DRIER MILLS
AIR SEPARATORS
VIBRATING SCREENS
COMPLETE "Packaged" PLANTS For Installation In Existing Buildings

At Your Service

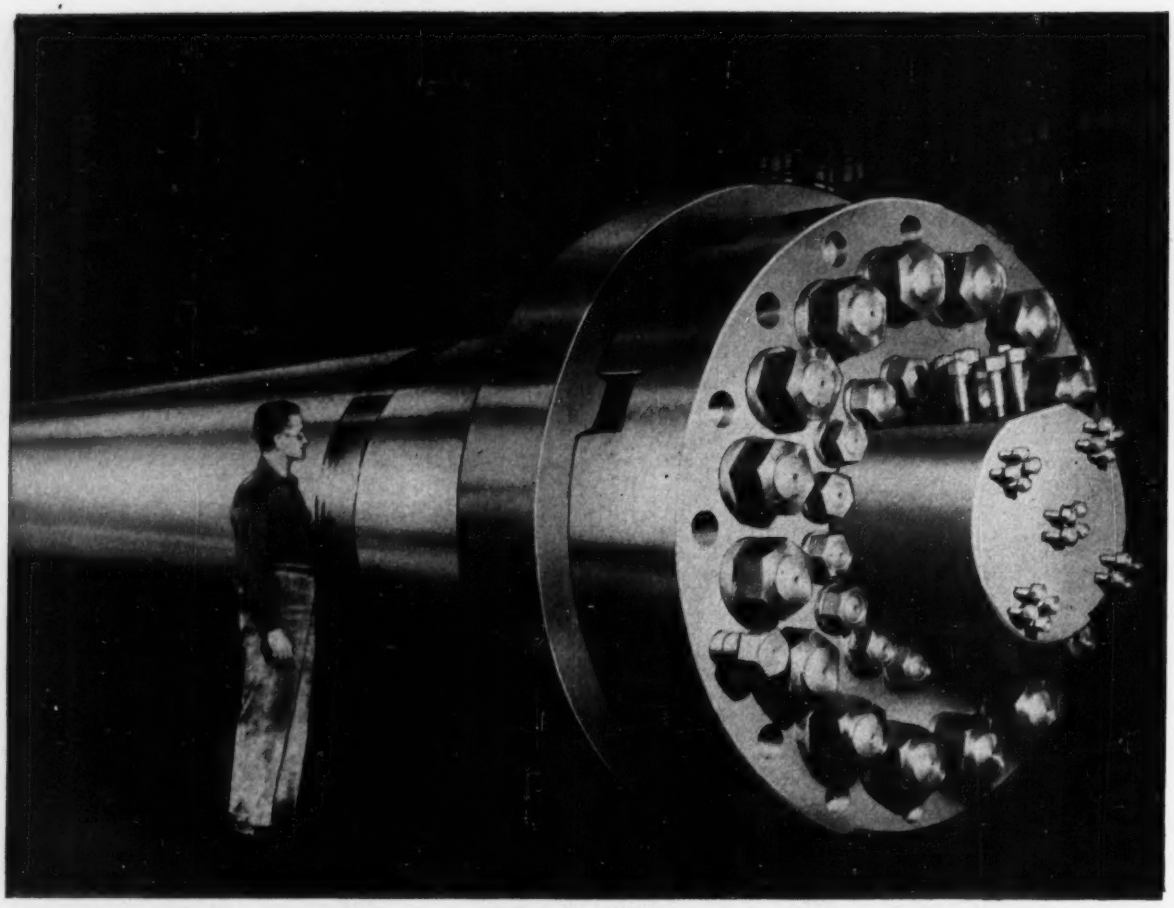
WILLIAMS TESTING LABORATORY

Consult Williams on any grinding, crushing, shredding or separation problem, no matter what the material. The most complete testing and research facilities are available without cost or obligation. Simply furnish enough raw material for a test run, and a sample or description of the finished product desired.

WILLIAMS

CRUSHERS — GRINDERS — SHREDDERS

OLDEST AND LARGEST MANUFACTURER OF HAMMER MILLS IN THE WORLD



PRESSURE STARTS *Right* AT THE BEGINNING!

Product—Converter
Working Pressure—4,500 P. S. I.
Inside Diameter—45"
Tensile Strength—75,000 P. S. I.
Material—Chrome-Vanadium Steel
Closure—Bridgman
Installation—Union Carbide and Carbon Corp. Texas City, Texas

Midvale pressure vessels are right from the start. Designed right in cooperation with customer's engineers. Made right from the pouring of the steel to final machining. Proved right by extensive sonic, hydrostatic, strain-gage and X-ray tests.

This big brute is an example of Midvale's vast experience and facilities and is the result of complete cooperation in design and building with the engineers of Union Carbide and Carbon Corporation.

This pressure vessel started as a 550,000 pound ingot of chrome-vanadium steel, poured by Midvale's steel making specialists. Then carefully hollow forged to rough shape on 14,000 ton and 7,500 ton presses . . . hydrostatically tested at 9,000 P. S. I. for a working pressure of 4,500 P. S. I. It has been successfully operating for years at Texas City, Texas.

Forged steel converters, reactors, separators, autoclaves . . . any size or type . . . Midvale has the complete facilities and the experienced craftsmen to make them to withstand high pressures, high temperatures and resist corrosion. Next time your plans include pressure vessels get in touch with Midvale. Let our engineers work with you from initial design to final installation.

THE MIDVALE COMPANY-Nicetown, Philadelphia 40, Pa.

Offices: New York, Chicago, Pittsburgh, Washington, Cleveland, San Francisco

MIDVALE

FORGINGS, ROLLS, RINGS, CORROSION AND HEAT RESISTING CASTINGS

Here's what makes the tractor shovel an outstanding performer on big-capacity material handling —

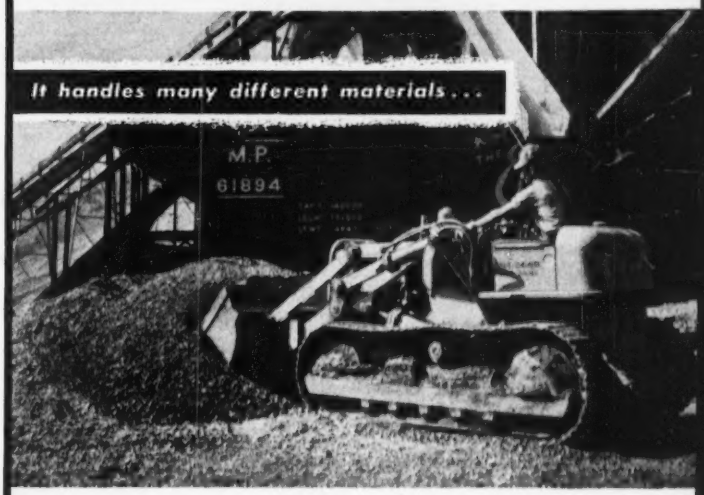
Users everywhere are finding the Allis-Chalmers HD-5G Tractor Shovel an excellent way to reduce production costs — not only because of its big handling capacity and economy, but because of its unusual versatility as well.

With Standard 1-yd. Bucket it is ready for any bulk material — loads trucks, feeds hoppers and conveyors, builds stockpiles.

With Lift Fork attachment it skids, stacks or loads packaged or palletized loads up to 4,000 lb., steel beams, pipe, lumber.

With big 2-yd. Light-Materials Bucket it doubles output in coal, coke, other light materials.

Where desired, the HD-5G can be adapted to other special requirements through use of Narrow Bucket, Rock Fork, Crane Hook — any of 13 attachments in all. These can be interchanged in about 20 minutes by simply removing and replacing four pins.



It handles many different materials . . .

. . . works anywhere . . .

The thousands of HD-5G's can be found working indoors and out — in pits and mines, on stockpiles, around all types of plants. Their crawler treads provide traction for soft spots or steep climbs, smooth out travel over rough ground, fit them to work anywhere. Because of compactness and maneuverability, HD-5G's handle well in close quarters. With an over-all height of about 6 ft. (bucket down), they are used on many underground and other low-headroom jobs.

. . . in any weather

In winter, the HD-5G clears snow from yards, roads and parking lots — in addition to regular duties. With 40 brake hp., 16,200 lb. of weight and plenty of track on the ground, it isn't stopped by snow, ice or mud. Cabs protect operators from cold or sun.

— also does other work

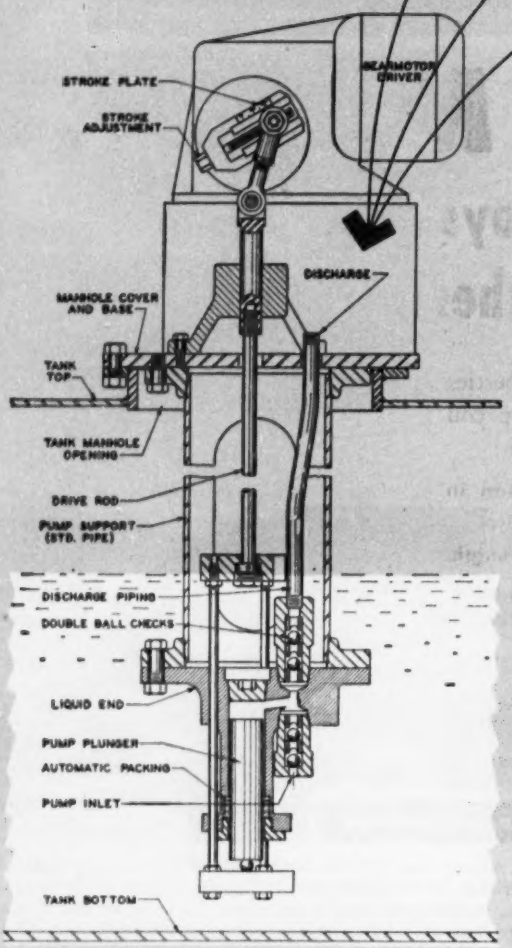
The HD-5G isn't limited to handling materials. It clears or levels land for new construction, digs basements and trenches, backfills, builds and maintains roads, stockpiles and reclaims coal, saves money and man-hours on dozens of jobs the year around.

Ask for a demonstration — Your nearby Allis-Chalmers industrial tractor dealer will be glad to *show* you just what the HD-5G or one of the larger 2-, 3- or 4-yd. Tractor Shovels will do —right on your own job. Or write for additional information.

ALLIS-CHALMERS
TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

CONTROLLED VOLUME PUMPS ARE FLOW-CONTROL INSTRUMENTS

- no leakage to atmosphere
- no diaphragm
- no contamination



MERSEMETRIC®. . .

the new controlled volume pump for submerged operation

Here's a new member of the family of Milton Roy Controlled Volume Pumps. The Mersemetric pumps by direct volumetric plunger displacement, using the exclusive double ball-check on both suction and discharge. Simple and compact, this new pump eliminates the need for a diaphragm. As a result, there can be no fluid contamination. Since Mersemetric is submerged in the fluid being pumped, there can be no leakage to atmosphere.

TYPES *Capsulated or drop-in-tank*

CAPACITIES *3 milliliters per hour to 400 gallons per hour*

MAXIMUM PRESSURE *To 1000 pounds per square inch (psi)*

MATERIALS *Full alloy selection*

DRIVE *Air or electric motor*

CAPACITY REGULATION *Manual or automatic and fully adjustable while in operation*

USE *As single units in integrated pumping systems or as final control elements in process instrumentation*

For complete details, write today, for Bulletin 1153-B.

The MERSEMETRIC® Controlled Volume Pump is designed to eliminate leakage of corrosive or expensive liquids by being submersed in the liquid being pumped. One of its specific applications is pumping concentrated sulphuric acid directly from the main storage tank to point of application, eliminating intermediate tankage or handling by personnel.

MILTON Roy COMPANY

Manufacturing Engineers

1322 E. MERMAID LANE • PHILA. 18, PA.

Engineering representatives in the United States, Canada, Mexico, Europe, Asia, South America and Africa.

CONTROLLED VOLUME PUMPS AND AUTOMATIC CHEMICAL FEED SYSTEMS

*Patent Applied For

AMPCO®

Producers of... "The Metal Without an Equal"

AMPCO* METAL

...the special alloys that make good where other metals fail

HERE are some of the properties of Ampco Metal that help you keep production up, costs down:

- **Excellent resistance to corrosion in certain media.**
- **High tensile and compressive strength.**
- **Unusual resistance to wear from abrasion, erosion, and cavitation pitting.**
- **High physicals at extreme temperatures.**
- **High rate of heat transfer.**
- **High impact and fatigue values.**

Because it combines all of these qualities, Ampco Metal is often called The Metal Without an Equal.

No matter what you do — whether you work in the chemical or process industries, refine oil, run a steel mill, make stampings, generate power, or any of hundreds of other jobs, you can make Ampco Metal work for you. It saves operating headaches and production grief, because it often makes good where other metals fail.

These versatile special alloys fight wear, corrosion, impact, fatigue; give long life and dependable performance under the severest conditions. That's why they are widely used in such tough assignments as fractionating towers, exchanger components, slippers and screw-down nuts for blooming mill service, aircraft parts, dies, valves, bushings, and other punishing jobs.

Chances are Ampco Metal can help you, too. It's available in sand and centrifugal castings, sheets, plates, bars, tubes, extrusions, welding wire and electrodes. Consult your nearby Ampco field engineer or write us for full information.

*Reg. U. S. Pat. Off.

AMPCO®

AMPCO METAL, INC.
Dept. CE-6 • Milwaukee 46, Wisconsin
West Coast Plant, Burbank, California

Ampco Metal, Inc.
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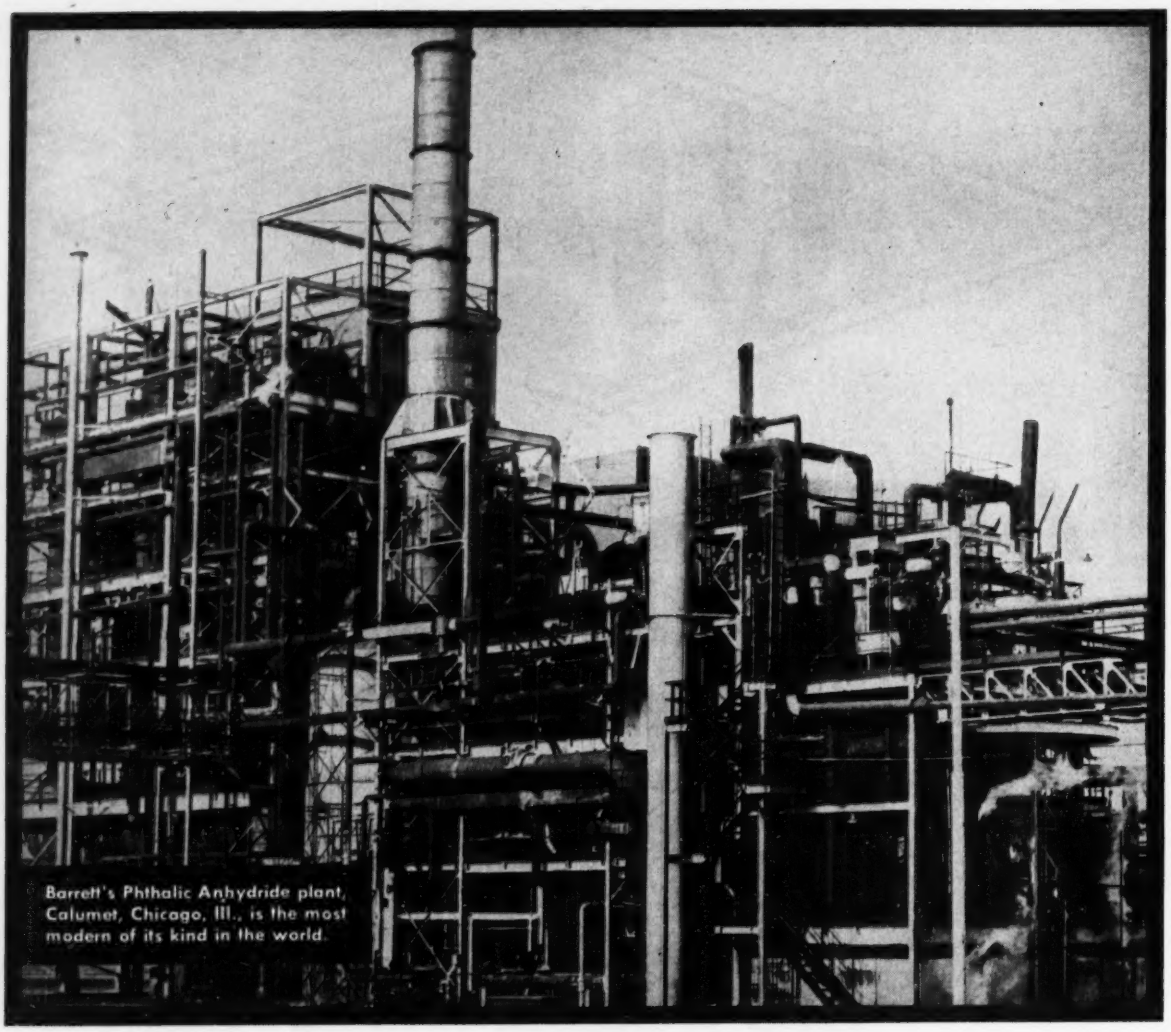
I am interested in learning more about the properties and uses of Ampco Metal in the process industries. Please send me literature.

Name.....Title.....
Company.....
Company Address.....
City.....(.....) State.....

PR-16



Barrett's Phthalic Anhydride plant, Calumet, Chicago, Ill., is the most modern of its kind in the world.

First name in Coal-Tar chemicals... last word in Phthalic production

Because of ever-widening use of Phthalic Anhydride, Barrett last year launched a large scale expansion program — both in increased production and more extensive research. One of the most notable developments at Barrett has been the addition of the Chicago Phthalic Anhydride plant. The most highly instrumentized Phthalic plant in the world, it brings production up to new high levels of automation — and assures an end product of unexcelled purity.

Because of Barrett's position as the world's leading producer of coal-tar chemicals, we are able to serve your needs promptly and efficiently. Technical assistance on your application problems is available without obligation.

BARRETT DIVISION, Allied Chemical & Dye Corporation, 40 Rector Street, New York 6, N. Y.
The Barrett Company, Ltd., 5551 St. Hubert St., Montreal.

Barrett Phthalic Anhydride is available in both flake and liquid forms, whichever better suits the customer's convenience.

1854 1954 CENTENNIAL Barrett

BARRETT CHEMICALS

You Pay More For HEAT-FAG...

... than for the blower that keeps men cool

When hot, stagnant or fume-filled air distresses your men, your production suffers too.

Give men around furnaces or hot processes, or in confined areas, a steady supply of fresh, cool air with Coppus Blowers and Exhausters and watch their efficiency jump to a more profitable level.

There's a portable, easily adaptable Coppus "Blue Ribbon" product for practically any fresh-air requirement. The Coppus "Blue Ribbon" is the sign of precision workmanship and trouble-free, long-lasting operation. Check and mail the coupon for exact information. Sales offices in THOMAS' REGISTER. Other "Blue Ribbon" Products in CHEMICAL ENGINEERING CATALOG, REFINERY CATALOG, BEST'S SAFETY DIRECTORY, MINING CATALOGS.

OTHER COPPUS "BLUE RIBBON" PRODUCTS

HORIZONTAL TURBINE
Six frame sizes—
1 to 150 horsepower

VERTICAL TURBINE
Six frame sizes—
1 to 150 horsepower

FANMIX GAS BURNER

FANMIX GAS-OIL BURNER

MAIL THIS COUPON To Coppus Engineering Corp., 226 Park Avenue, Worcester 2, Mass.

PLEASE SEND ME INFORMATION ON SUPPLYING FRESH AIR TO MEN WORKING:

- ☐ in tanks, tank cars, drums, etc.
- ☐ in underground cable manholes.
- ☐ in aeroplane fusilages, wings, etc.
- ☐ on coke ovens.
- ☐ on steam-heated rubber processes.
- ☐ on boiler repair jobs.

COOLING:

- ☐ motors, generators, switchboards.
- ☐ wires and sheets.
- ☐ general man cooling.
- ☐ around cracking stills.
- ☐ exhausting welding fumes.
- ☐ stirring up stagnant air wherever men are working or material is drying.
- ☐ drying of walls, sheets; etc., after treated with coating material.

NAME .....

COMPANY .....

ADDRESS .....

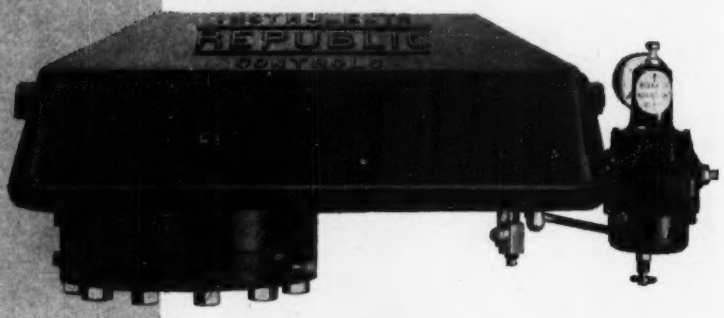
CITY .....

(Write here any special ventilating problem you may have.)

COMBINES MACHINE RUGGEDNESS WITH INSTRUMENT PRECISION for dependable low maintenance metering

REPUBLIC

pneumatic transmitter for measuring FLOW, PRESSURE, LEVEL or DENSITY...



Machine dependability with instrument accuracy and sensitivity! Think what this combination of features can mean in your plant—less maintenance, longer life for lowest "long run" cost, *continuous* accurate operation.

You get all of these benefits and more with the Republic Pneumatic Transmitter. Force-balance operation permits the use of strong rugged parts with no sacrifice in accuracy or sensitivity. Gives exceptional overrange protection.

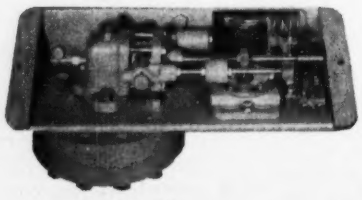
Housed in a durable metal case, the transmitter may be adjusted for mounting at any angle, indoors or out. Its accuracy is not affected by changes in ambient temperature vibration, normal changes in supply air pressure or inaccurate leveling. Uses no mercury or purge pots. Can be used with very viscous fluids.

The Republic transmitter isolates fluids to a measuring chamber which may be supplied in a variety of corrosion resistant materials. It sends an air pressure proportional to fluid flow, pressure, level or density to reading instruments or for actuation of an automatic controller.

Republic Pneumatic Transmitters are proving their superiority in hundreds of chemical and oil field applications. Investigate their advantages for you — write for your free copy of 36 page Data Book No. 1004.

SPECIFICATIONS:

ACCURACY—½% of maximum range guaranteed for standard models.
DIFFERENTIAL RANGES—Any desired span between 0-0.6" H_2O and 0-750 psi at operating pressures of 15 psig to 2000 psig.
PRESSURE RANGES—Any desired span between 0-1" H_2O and 0-2000 psig.
LEVEL RANGES—to meet almost any application.
DENSITY RANGES—0.15 sp. gravity spread for 3 to 15 psig output pressure from any base density.
Extremely wide range change is possible without change of parts. Ranges may be easily changed, suppressed, compounded or reversed.



● ***EASILY SERVICED*** Cover can be completely removed for access to all range adjustments and replaceable parts. No special tools required.

REPUBLIC FLOW METERS CO.
2240 Diversey Parkway, Chicago 47, Illinois

Get in on the ground floor!

The circles on the map represent unclaimed territories for the production of complex fertilizer. The pin locates the only plant presently producing complex fertilizer by a continuous chemical process.

New economic frontiers don't remain undeveloped for long. There is still time to get a choice location before the rapidly moving trend toward high analysis complex fertilizer *completely engulfs the country.*

Get C&I's complex fertilizer plant using the PEC* patented carbonitric process that produces a superior and stable pelleted product for less than any existing process.

C&I will provide a complete and integrated plant or any of the individual units (ammonia, nitric acid, complex fertilizer) for the production of complex fertilizer in any desired capacity. Plants are erected at a fixed price with productions and efficiencies fully guaranteed.

C&I can also furnish the latest type ammonium nitrate solutions and solids plants.

* Procédé de Engrais Chimiques

PEC

Specialists in C&I *Processing Ammonia*

THE CHEMICAL & INDUSTRIAL CORP.

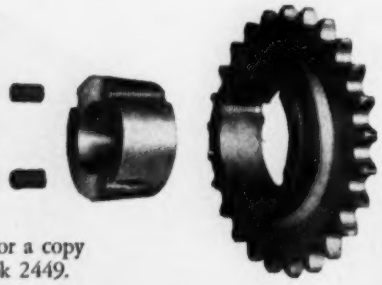
CINCINNATI 26, OHIO

SAVE TIME! SAVE MONEY!

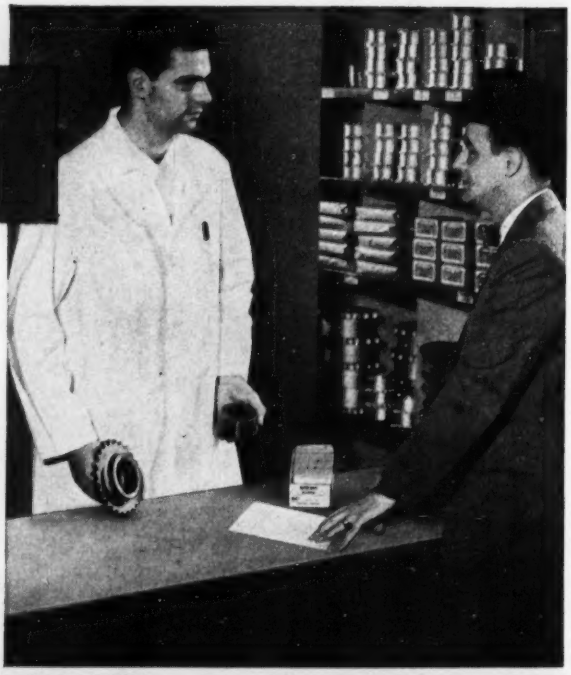
Use Link-Belt roller chain sprockets with taper lock bushings

Faster, less expensive procurement!

There's no delay for reboring when you need sprockets in a hurry. You can pick these *right off the shelf.* Stocks include sizes for single width chains from RC-40 through RC-160.

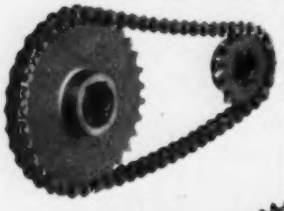


Send for a copy of Book 2449.

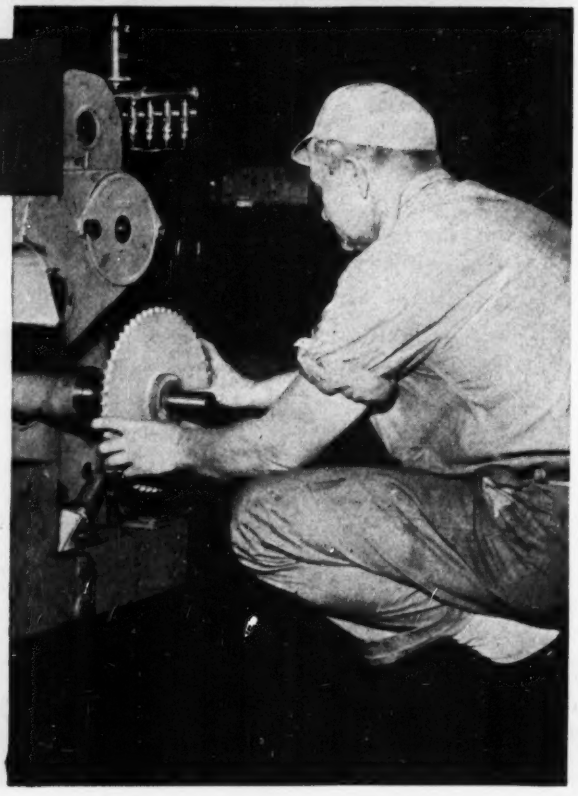


Faster, less expensive installation and removal!

No need to fit sprocket to shaft. Setscrews draw sprocket onto taper bushing, causing bushing to clamp tightly on shaft — equivalent to shrink fit. Turning setscrews in removal-holes quickly releases sprocket from shaft. Full bushing length supports sprocket on shaft.



AN IDEAL COMBINATION: Link-Belt Precision Steel Roller Chain and Link-Belt Sprockets



LINK-BELT

ROLLER CHAIN AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

13.807

ALL OVER THE PLANT... YOUR PLANT!

ROCKWELL Industrial Meters
WILL SAVE MONEY, MAKE MONEY FOR YOU!

Wherever valuable liquids are stored, mixed or consumed, you will be way ahead to measure them with Rockwell industrial meters. They provide *accurate* records to verify your purchases, to stop losses. They guard the quality of your formulations when blending, mixing, batching. Your accountants will welcome meter records for cost control and tax analysis purposes. These same records will enable you to keep tab on all liquid inventories.

There is a size and type of Rockwell meter to measure most any liquid that can be piped—oils, chemicals, paints, liquors, solvents, etc.—even corrosive fluids. Automatic shut-off valves and remote registration systems are available. For full facts use the handy coupon or write for bulletins.

Rotocycle meter, cut away to show the all-revolving rotor construction.

NOW

A STAINLESS STEEL METER

FOR MEASURING CORROSIVE LIQUIDS

This Rockwell Model 2-BC meter is constructed *inside and out* of stainless steel. It resists corrosion. Rated capacity 100 gpm. This is an ideal meter for measuring liquids entering into foods and pharmaceuticals—also chemicals and corrosive liquors. Write for bulletin OG-403.

YOU CAN RELY ON ROCKWELL

CLIP COUPON—MAIL TODAY

C5402A

ROCKWELL MANUFACTURING COMPANY
Pittsburgh 8, Pennsylvania

Gentlemen:
I am interested in measuring _____
(Name of Liquid)
Pipe Size _____"
Working Pressure _____psi. Temperature _____°F max.
Max. Flow Rate _____gpm. Min. Flow Rate _____gpm.
YOUR NAME _____
COMPANY _____
STREET _____
CITY _____ ZONE _____ STATE _____

Eli Lilly and Company adjusts the weather in drug packing cabinets...

To assure accurate measurement, vital drugs should be weighed in a DRY atmosphere. This girl works through sealed hoods, weighing drugs and filling ampoules at Eli Lilly and Company, Indianapolis. The Lectrodryer at the right feeds DRY air to her cabinet.

Regardless of outside humidity, the air inside this drug packing cabinet is held at a moisture content of 2.5 grains or less per cubic foot. Sensitive drugs require such DRYness to retain their potency and chemical balance.

Lectrodryers DRY the air for these cabinets at Eli Lilly and Company, Indianapolis. A woman, supervising the drug packing, watches cabinet humidity and adjusts the DRY air feed to maintain a constant low-moisture condition.

DRYness to speed production or to protect a product may be exactly what you need. A Lectrodryer* can provide that DRYness. Lectrodryers are DRYing air, other gases and organic liquids in volume to dewpoints as low as -110°F...to relative humidities lower than 10%.

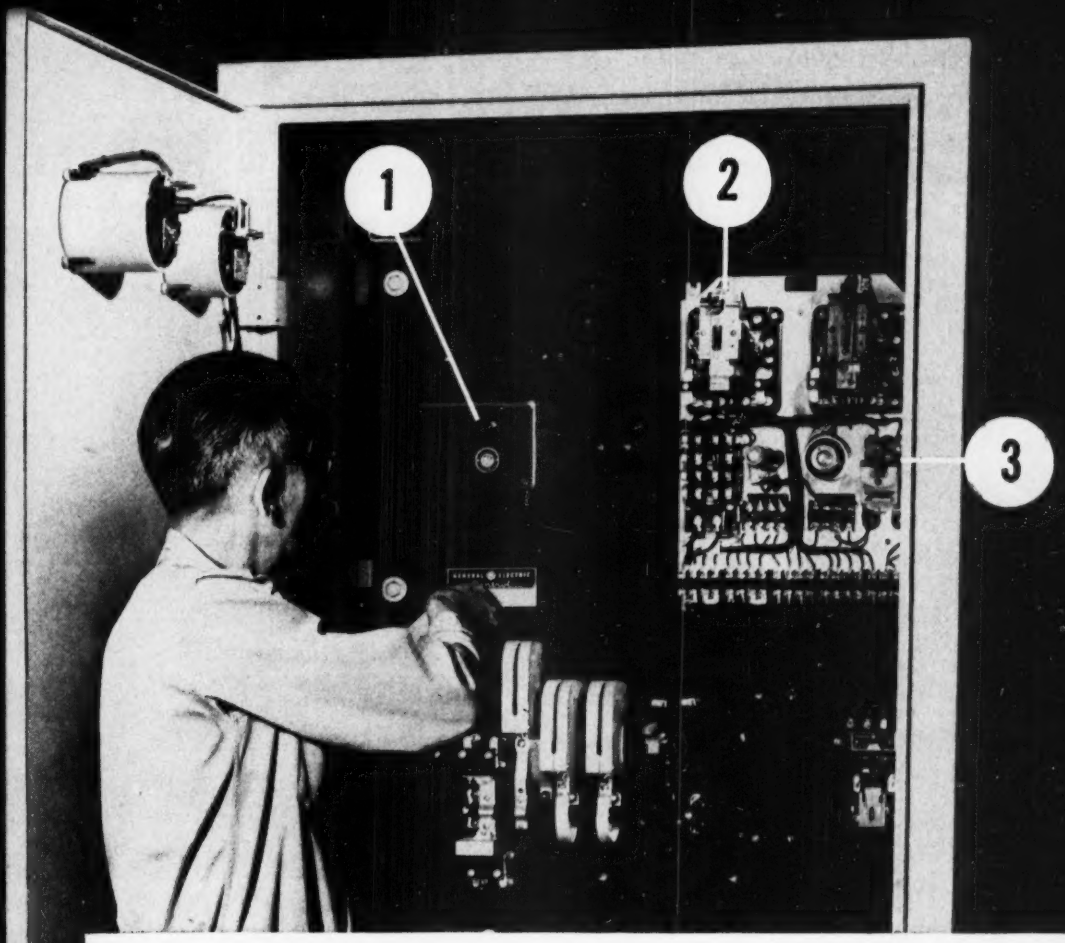
Write for *Because Moisture Isn't Pink*, a booklet telling you about typical Lectrodryer installations in various industries and how these machines may help you. Pittsburgh Lectrodryer Corporation, 303 32nd St., Pittsburgh 30, Pa.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

*REGISTERED TRADEMARK U.S. PAT. OFF.



Only G.E. Gives You These 3 Features in Standard Synchronous Motor Control at No Extra Cost

1. GRADUATED SQUIRREL-CAGE PROTECTION Relay protects motor during stall or subsynchronous operation. Protects squirrel-cage winding against overheating.

2. PRECISION ANGLE SWITCHING Field application relay takes fullest advantage of motor's synchronizing ability—applies field at correct speed and most favorable angle between rotor and stator poles.

3. LOAD ANGLE FIELD REMOVAL Fastest field removal available assures long motor life. Power-factor relay removes field within first half slip cycle out of synchronization.

You get these and other big features in ***standard*** G-E synchronous motor control at no extra cost. Be sure to get complete details—contact your nearest G-E Apparatus Sales Office or use the convenient coupon to get our new 16-page descriptive bulletin.

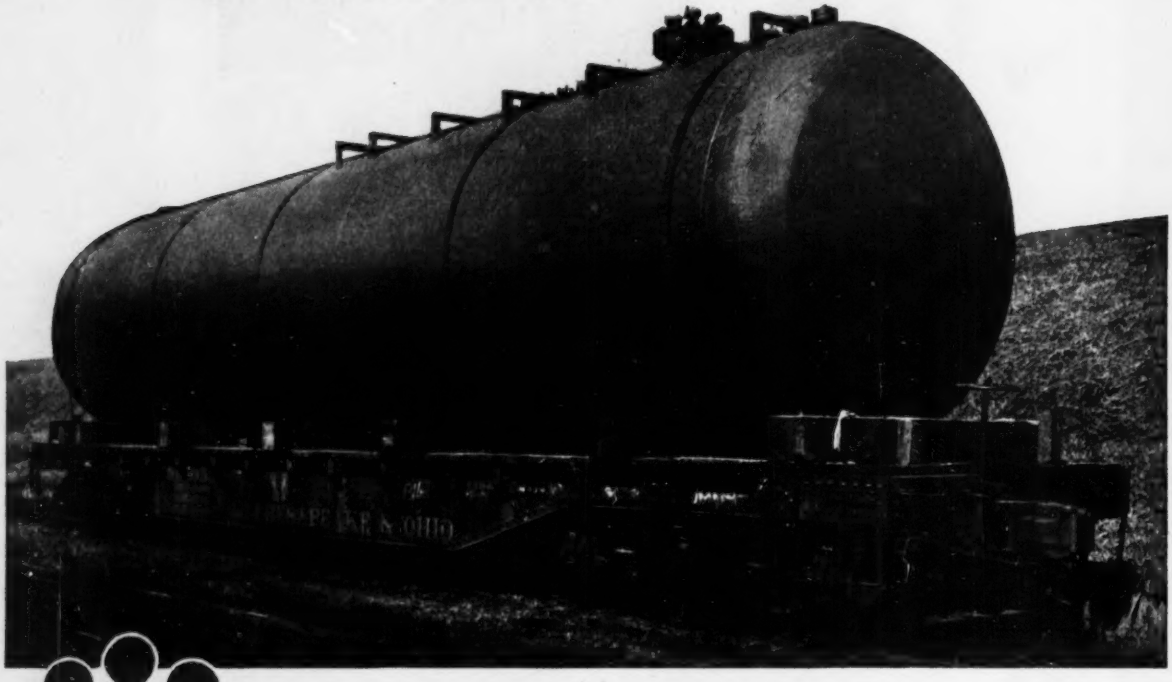
Section L 780-3
General Electric Company
Schenectady, N. Y.

Please send me your new bulletin, GEA-5873 which gives complete information on G-E Synchronous Motor Control.

Name .....
Position .....
Company .....
Address .....
.....

GENERAL ELECTRIC

One of six 51-foot liquid chlorine horizontal storage tanks built and tested by Newport News to meet A.S.M.E. Code requirements. This pressure vessel was welded by Union melt machines. Pressure vessels undergo stress-relieving treatment in our ovens.



Large Units...

single or multiple

Built with careful attention to detail by specialists in Metal Fabrication

Whether specified in alloyed or carbon steel, stainless, high nickel alloys or clad . . . you'll find it pays to have Newport News fabricate your large units.

Avail yourself of the specialized production techniques, and the skill of Newport News craftsmen operating vast steel fabricating shops.

Units of large dimension are readily constructed by Newport News in a 225-acre plant that includes five huge, fully equipped machine shops, drop forging and die facilities, heat treating ovens, and acres of brass, iron and steel foundries.

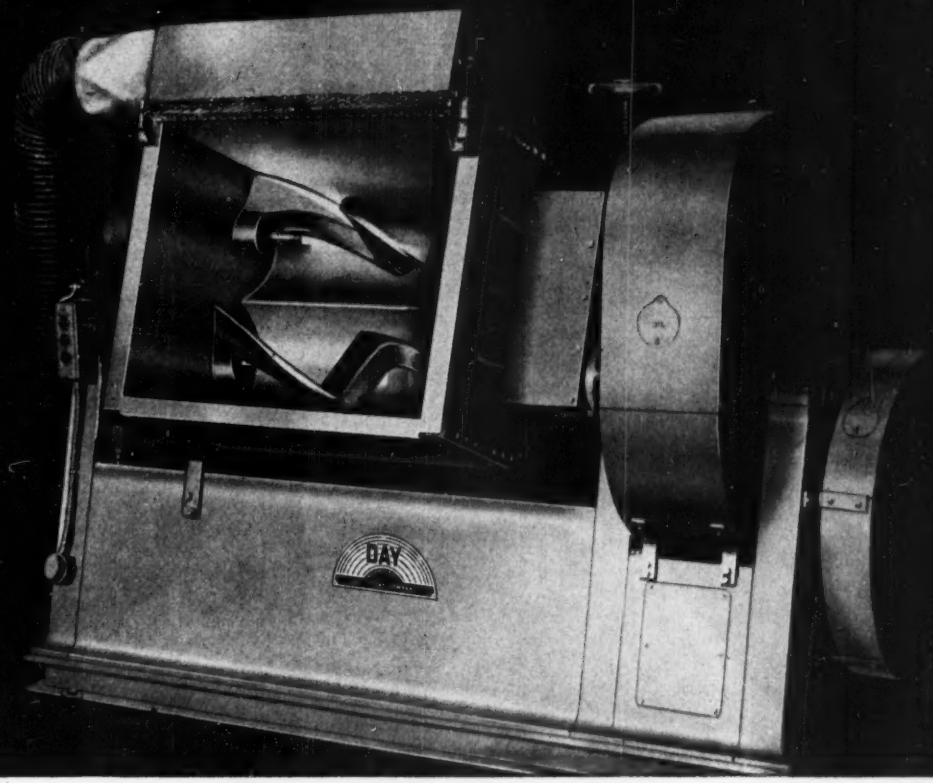
Moreover, modern testing apparatus, used for thorough investigation of materials and techniques, contributes to the excellence of Newport News fabrication. In addition, Newport News shop erection of fabricated units assures trouble-free assembly at your plant site.

Let us bid on your present or future projects. If you are not familiar with the way Newport News can help you, write for our booklet entitled *"Facilities and Products"*. . . it's yours for the asking.

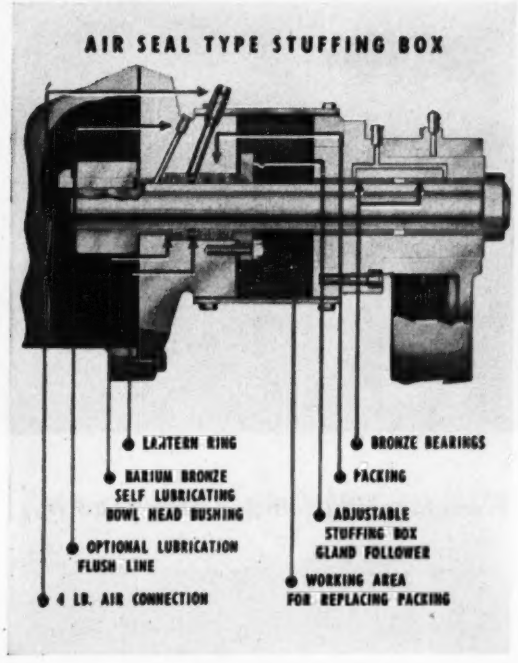
Newport News Shipbuilding and Dry Dock Company

Newport News, Virginia

DAY means longer life span



DAY Imperial Mixer installed at Woodall Industries, Detroit, Mich.



✻ Built for heavy duty, engineered for precision . . . this combination makes DAY's Imperial Mixer extra long-lasting and serviceable. It has been re-engineered with major advances in design, assuring fast, thorough dispersion mixing of heavy plastics and colors in paints and inks, as well as sludge reclamation in paints and enamels.

Shown at left is one of the Imperial Mixer's most valuable features . . . the Air Seal Type Stuffing Box. Pneumatic pressure at 4-10 lbs. protects your product against contamination by lubricants and guards bearings from damage by abrasive mixtures. CO_2 may be substituted for air. For details, call your nearest J. H. Day field engineer or write for Bulletin 600.

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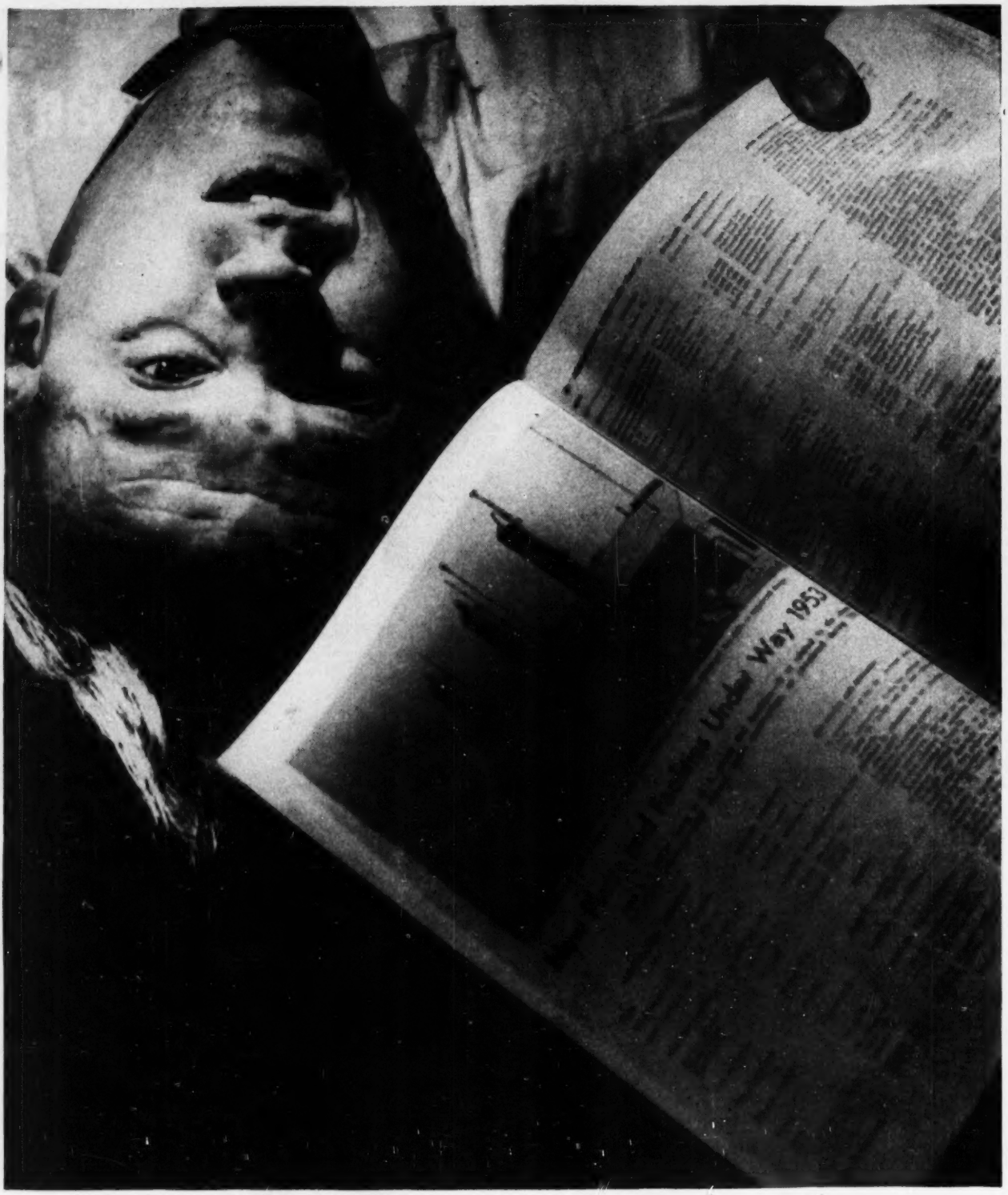

more engineering-minded men read it...

✳ *Calvin Cronan,*
Assistant Editor of
CHEMICAL ENGINEERING

How's it look from there, Calvin?*

Funny way to work up an "Inventory Issue." What's an editor doing upside down? But why not ask Cal Cronan? That's him, hanging from the ceiling.

"Come on, lemme down! Or so help me, I'll toss you that old cornball about this issue looking 'good from any angle.' It does too!

Truth is, though, I could get this way easy – just examining the mountain of material we're combing through for your September special. I knew chemical processing was a hot field but had no idea so much new stuff came along in a year's time.

New stuff? Sure, like . . . new developments in plants and facilities – in processes and technology – in equipment and accessories – in chemicals and raw materials – in new technical literature from manufacturers. Everything's new and different for this issue and it's all designed to provide maximum usability for the reader. Even got a streamlined new method for indexing Reader Service.

Funny thing, though. The woods are full of new developments but I guess we're getting kinda fussy in our old age. We're throwing out half the stuff we receive because it just doesn't stand up as significant CPI contributions.

We think you'll go along with this 'selectivity' idea, though. After all the purpose of this issue isn't just to provide a 'Wrap up' of CPI progress – it's more than that! The objective is to give you a practical, 12-month summary of the really *important* developments that affect the chemical engineer, his job and his future.

'Nuff said? Somebody else'll tell you more next month. Meanwhile, don't forget the date . . . it's September for CHEMICAL ENGINEERING's first 'Annual Inventory Issue'." *Calvin Cronan*, Assistant Editor.

more chemical engineers profit from it . . .

Chemical Engineering

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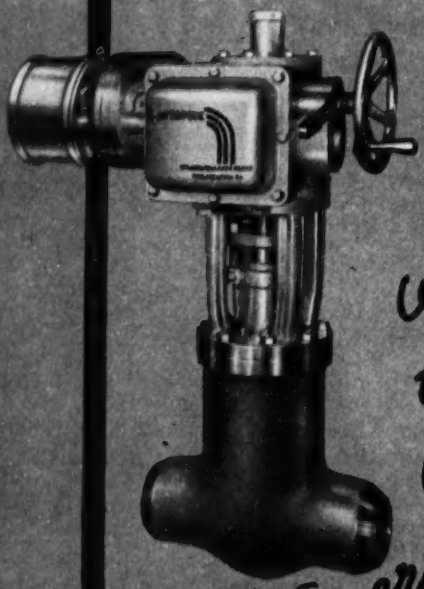

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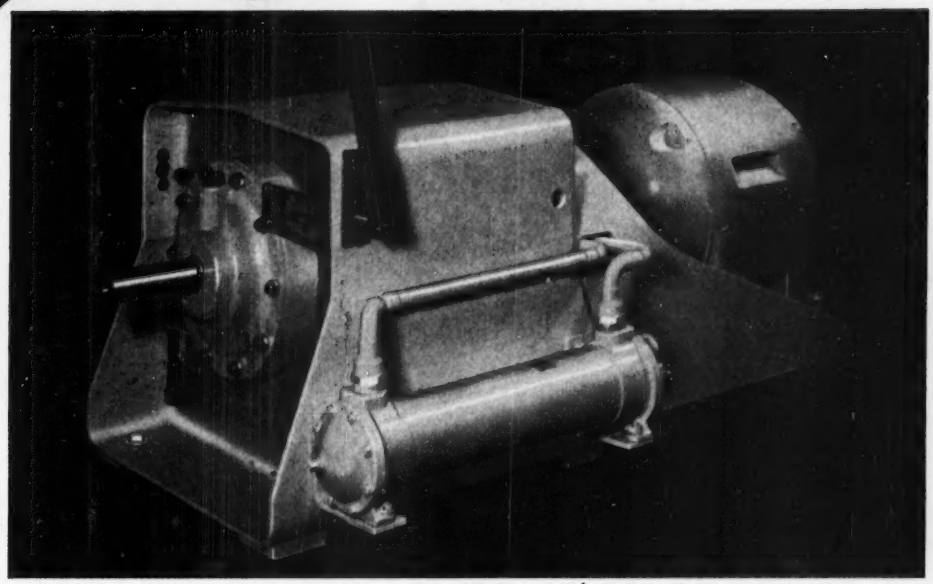
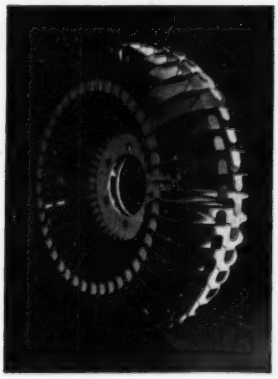


American Blower Type VS Class 2 Gýrol Fluid Drive



A phantom view of the driving and driven members, which provide smooth, reversible power transmission.

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- **Permits adjustable speed control over a wide range**
- **Built in several standard arrangements**

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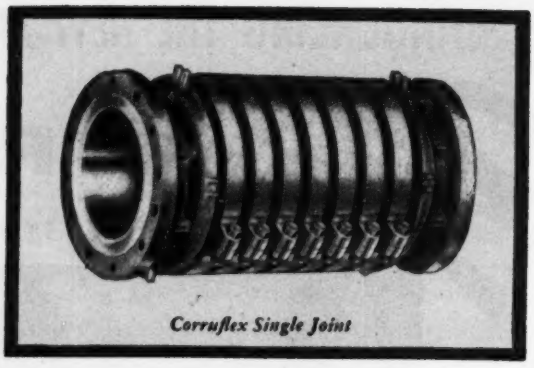
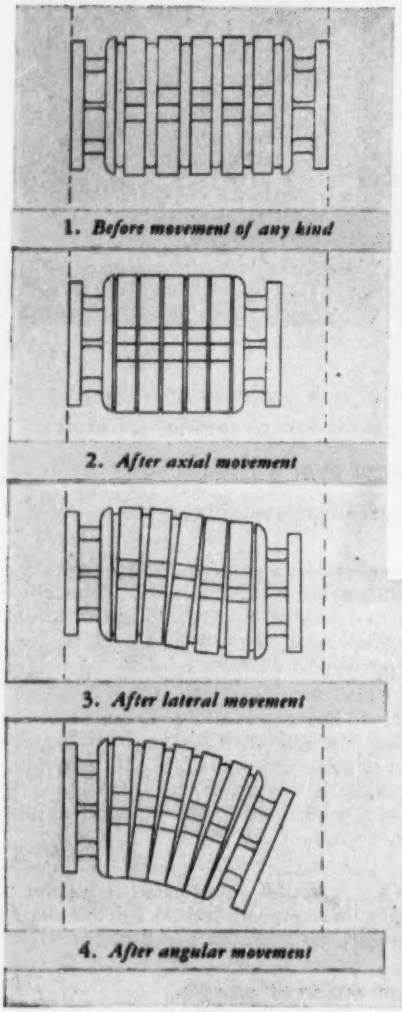


Corruflex Single Joint



Why worry about maintenance in pipe lines when you don't have to? Install ADSCO Corruflex Expansion Joints... they are packless and require no maintenance. Put 'em in the line and forget 'em.

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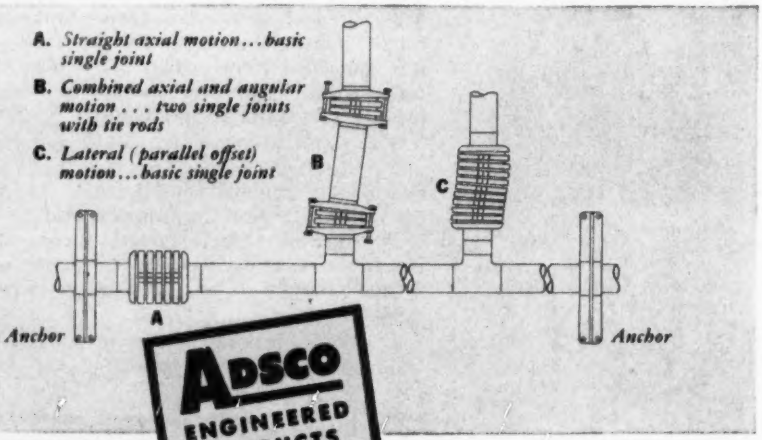
Drawings 1 & 2 at left show accordion-like movement as the Basic Single Joint opens and closes to absorb axial movement. In Drawings 3 & 4, note that maximum lateral deflection and maximum angular rotation are obtained when joint is in median position. ADSCO can supply complete tabular data on the maximum amount of allowable lateral and angular movement either side of center line. Under certain conditions, such as the addition of extra corrugations, the Basic Single Joint can be used to absorb combined axial and lateral or combined axial and angular motions.

For assistance in laying out piping systems, a cordial invitation is extended to you to consult ADSCO's engineering staff. Phone your ADSCO representative about this service or write the factory direct.


A. Straight axial motion... basic single joint
B. Combined axial and angular motion . . . two single joints with tie rods
C. Lateral (parallel offset) motion... basic single joint
B
C
A
Anchor
Anchor

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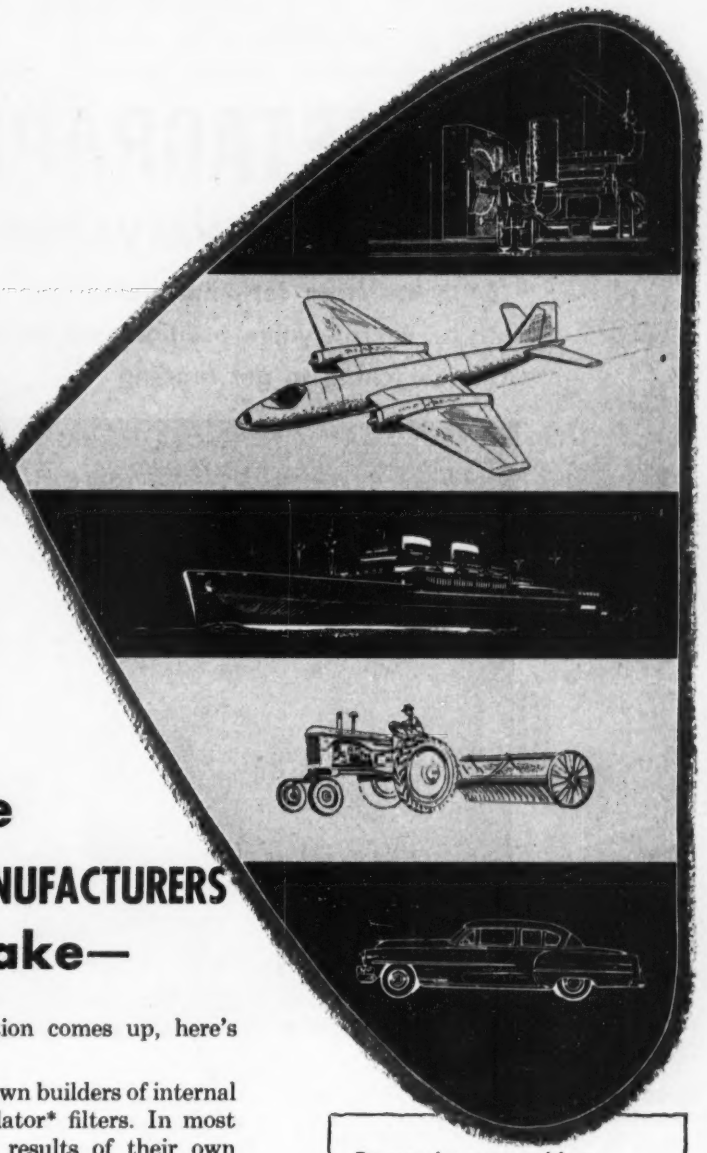

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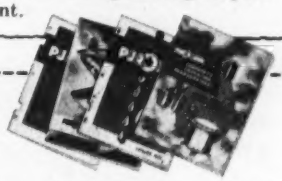

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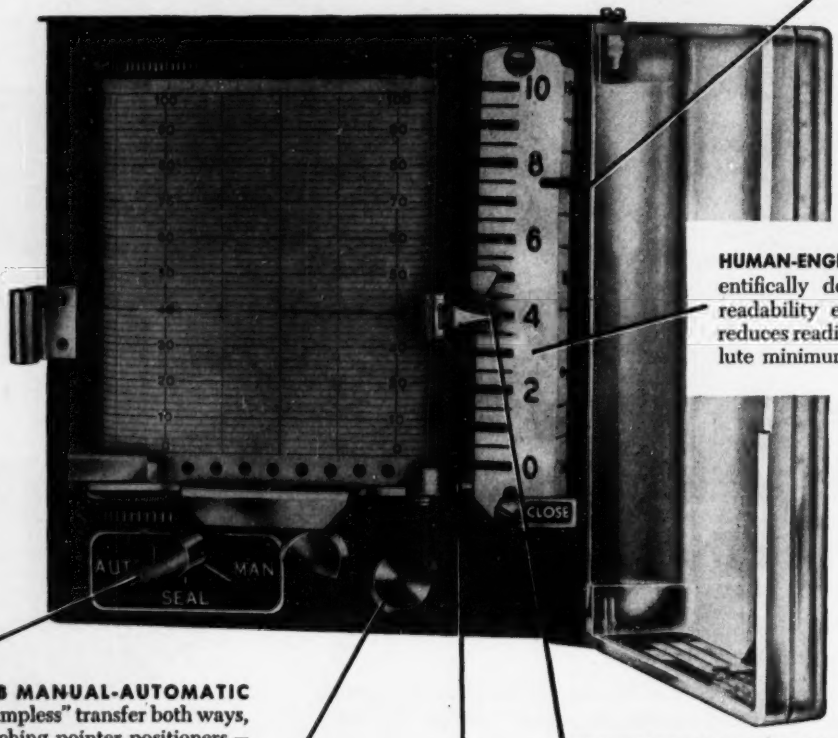

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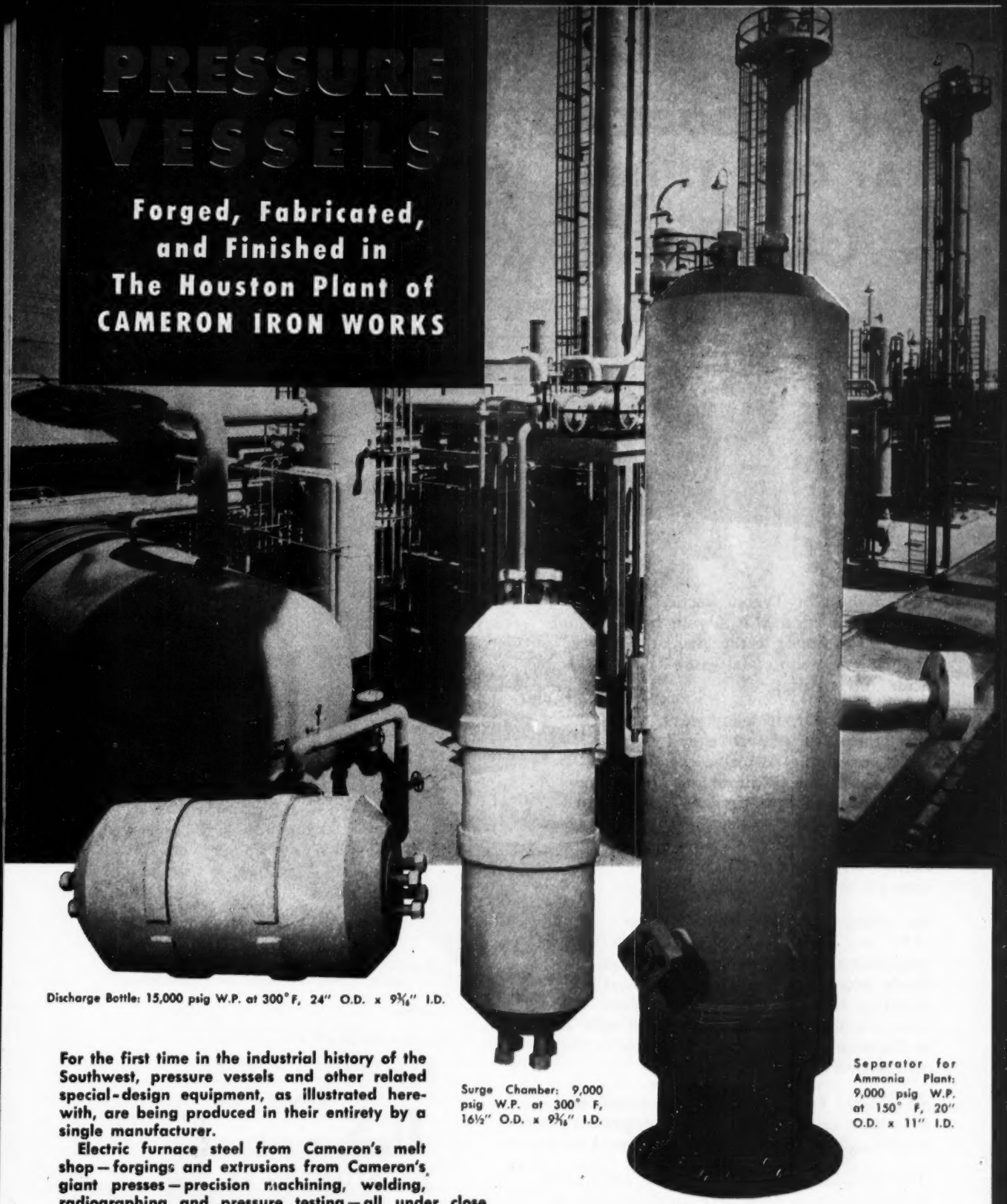

Discharge Bottle: 15,000 psig W.P. at 300°F, 24" O.D. x 9 3/16" I.D.

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JUNE 1954

Chementator

Edward T. Thompson

• Cell liquor carbonation to avoid costly evaporation will be used in Dow Chemical's forthcoming 300 ton per day soda ash plant at Freeport, Tex. Tricky CO_2 bubbling is the key. Building of the $3 million unit—first in the U. S.—starts this summer.

• Watch for two new noncellulosic synthetic fibers from Tennessee Eastman Co. There's no firm commercial go-ahead yet, but one is being market evaluated, the other pilot-planted.

Newborn pulp industry may get second mill

Alaska's first major manufacturing industry—wood pulping—off to a roaring start last month with the opening of the $50 million plant of the Ketchikan Pulp Co., will probably get another boost this month. On June 9 the U.S. Forest Service will auction another three billion board feet of Alaskan timber under terms that require the purchaser to install a pulp mill—minimum capacity 80 tons a day—by the end of 1962.

That's just the way the Ketchikan venture started. In 1948 the Forest Service sold 1.5 billion bd. ft. to the organizers of Ketchikan Pulp Co.—American Viscose and Puget Sound Pulp & Paper Co., Bellingham, Wash.—later upped the amount to eight billion bd. ft. This huge stand of timber has allowed the new mill to start operating immediately on a sustained-yield basis, a goal which most mills reach only after years of negotiating for the necessary timber.

The Ketchikan plant, with an annual capacity of 130,000 tons of dissolving pulp, is the first completely new pulp mill to use the magnesia base sulfite process developed at the Longview, Wash., plant of Weyhauser Timber Co. Both installations have been handled by Babcock & Wilcox Co.

Reason for selecting the magnesia base process, say company officials, is "the favorable character of this large pulp wood supply." Efficient chemical recovery will reduce shipping costs for nonrecoverable materials made by other processes. Also, it avoids water pollution that would quickly incur the wrath of the entrenched fishing industry.

And Ketchikan expects to achieve higher chemical recovery than the Longview plant, principally in the wash cycle and in the trapping of gas from the evaporation units. Other process improvements are minor, aimed mostly at extending the length of runs between shutdowns for maintenance. At Longview this period has never exceeded six months.

New and different styrene monomer process

Three ways different—different design, different equipment arrangement, different styrene inhibitor. That's how Foster Grant Co. describes its new monomer plant at Baton Rouge, La. It's the first one of its type in the U.S. not to be licensed by Dow Chemical Co.

And that's not all. Although most experts say the minimum investment needed to get into the styrene business is $10 million, Foster Grant decided that a small scale plant—ultimately 24 million lb. per year—was practical and invested only $4 million total. Yields are expected to be "in line" with those generally obtained in the Dow process—about 86.5 percent over-all.

On the surface, the new process closely resembles Dow's. Ethylene from Esso's Baton Rouge refinery and benzene are alkylated to ethylbenzene using an aluminum chloride catalyst. This is dehydrogenated in the presence of iron oxide to styrene which is separated from unreacted ethylbenzene and byproduct benzene-toluene by vacuum distillation.

The first step is similar to that used at other

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plants. To avoid infringing Dow's patents on dehydrogenation, however, Foster Grant came up with a new design and new simpler arrangement of its processing equipment, neither of which it's talking about right now. In the styrene purification—probably the toughest operation of all because the fractions boil so close together and styrene polymerizes so readily—Foster Grant turned to hydroquinone as a polymerization inhibitor. Dow uses elemental sulfur and *p*-tert-butylcatechol.

Possible later expansion was kept in mind when the new plant was laid out. But until that happens, and maybe afterward, all styrene monomer produced will go to the company's Leominster, Mass., polymerization, injection molding plant.

Government linseed oil sale may boost prices

If the Dept. of Agriculture succeeds in its plan to put 300 million pounds of linseed oil on the export market, domestic prices, paradoxically, will probably go up. The reason: U.S. producers will no longer have to worry about the possibility of this material hitting the domestic market.

This potential guillotine has been hanging over the heads of flaxseed crushers since 1951, when linseed oil was classified as a defense material. Now the pressure is off and the relief, according to one big producer, might jump the price to as much as 16c. per lb.—up from about 14.5c.

In selling the oil the government stands to lose over $60 million. Average cost was 28c. per lb., but it will probably be sold for about 7c. to meet foreign competition. And at that price there should be ready foreign markets, including countries like Russia that hydrogenate linseed oil to an edible shortening.

The original plan was to offer 100 million lb. a year in each of three years, starting in 1955. Now, however, USDA will try to get rid of it as fast as possible. Total linseed oil exports last year were slightly over 90 million lb.

New era for food and drug laws?

While it refers only to chemical pesticides, the Miller bill (H. R. 7125) introduced during the current session of Congress perhaps presages a fundamental modification of the over-all philosophy of food and drug laws. And as such it concerns far more than just agricultural chemicals.

Its primary goal is to simplify the setting of pesticide residue tolerances. Since passage of the current cumbersome Food and Drug Law in 1934, only one such tolerance has been established.

And in simplifying, the bill sets up two new concepts in FDA legislation that may lead the way toward similar legislation for such products as intentional food additives.

First, it calls for appointment of a scientific advisory committee on request of either the manufacturer or the Food and Drug Administration through its boss, the Secretary of Health, Education and Welfare. A tolerance (or exemption therefrom) would be set within 210 days of the request. If objections are expressed, a public hearing would be scheduled and adjudicated by the Secretary.

Then comes the second major change: If the Secretary's findings are challenged, the Appeals Court—not a District Court—would review the entire record. However, such findings could be negated only if the court found that there was no substantial evidence to back up the Secretary.

On food additives, a number of bills are currently being prepared. And it's safe to assume that the Miller bill's advisory committee and Appeal Court review will be included. Also, legislation will probably include an allowance for quantitative limits. Thus FDA could set a safety level for a chemical, rather than just approve or disapprove it.

Another big lithium products plant

Initial operations of a new $7 million lithium chemicals plant are scheduled for October of this year. To be built by Lithium Corp. of America at Bessemer City, N. C., it will turn out only lithium carbonate and hydroxide. If the demand for other lithium products increases, the company feels it can afford to ship the carbonate to its Minneapolis, Minn., installation.

Two major inovations are being incorporated. The plant will operate on ore run directly from the mine without the usual concentration step to eliminate gangue. Although this means they'll handle 4½ times as much ore per day, company officials say that skipping a processing step will more than compensate for it. In addition, the plant will be located right at the mine site.

Capacity production from the continuous plant is expected early next year. At that time it will employ 300 workers and will use over a million gallons of water and 2 million cu. ft. of natural gas per day. Engineering and design work are being done completely by the company's own engineers who will also supervise the actual building. Contracts for the latter were let early in May.

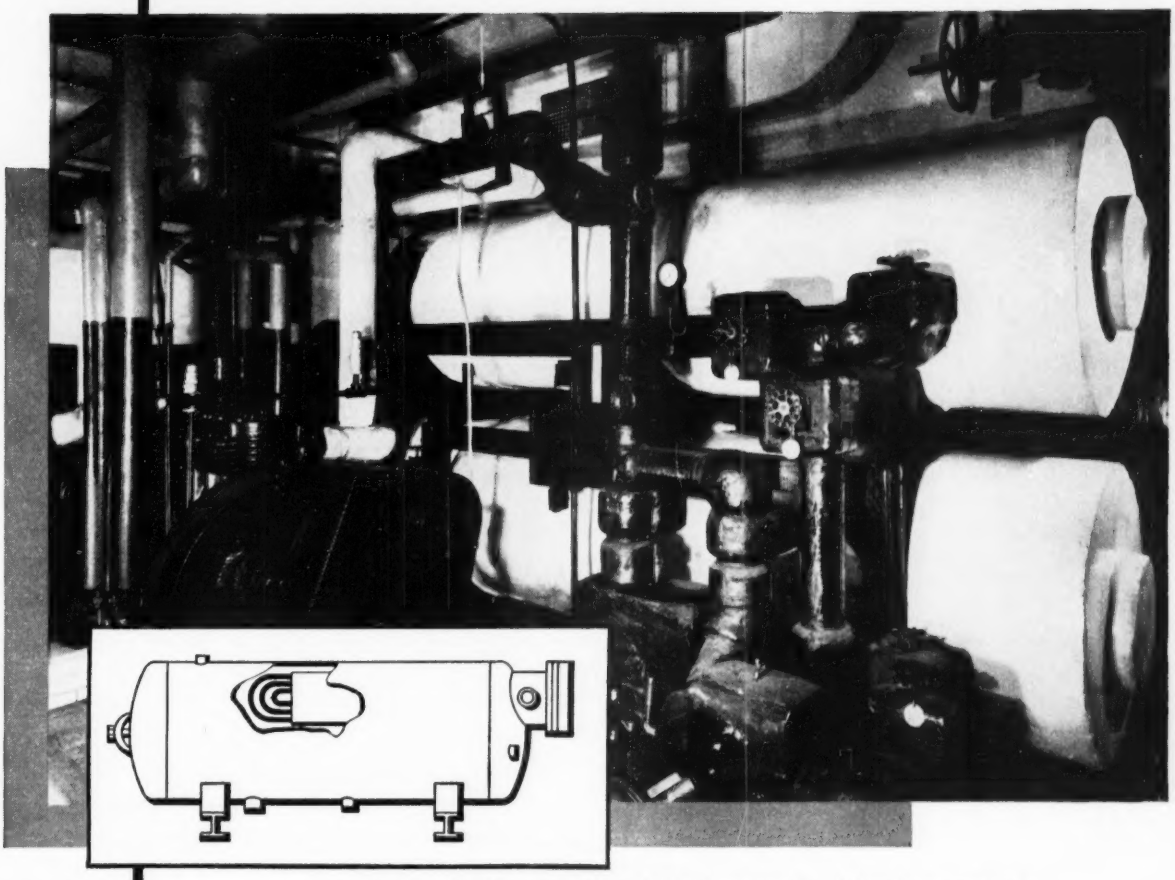
Lithium Corp. now owns 2,500 acres of spodumene deposits in North Carolina, said to be the largest lithium reserve in the Western Hemisphere.

(Continued on page 110)

COLD WATER STRATEGY

for processing operations

p-k chillers



A p-k chiller provides chilled water for blending, mixing, external cooling or wherever required in processing operations. p-k chillers feature a combination water storage tank and built-in chiller of corrosion-proof construction.

With this design, smaller chilling surface and refrigerator compressor capacity can be used and the load factor is improved. Individual water coolers are dispensed with and concentration of cooling facilities in one central location reduces initial investment and facilitates servicing. Fluctuating water requirements are easily met without temperature change. Any new or present compressor equipment can be used.

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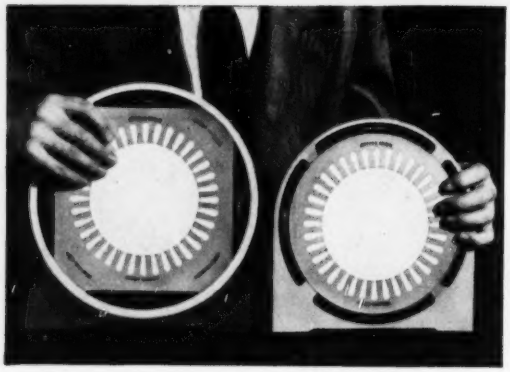
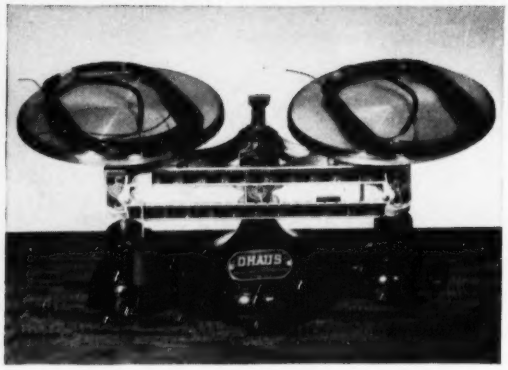
Here are laminations from two 5-hp Life-Line motors. Note that only the inactive support corners of the original Life-Line square stator have been eliminated from the round stator of the Life-Line "A" motor.



When the stators are placed in their respective frames we see how the Life-Line "A" size reduction has been accomplished without sacrificing active magnetic steel. Excess air space has been eliminated also.



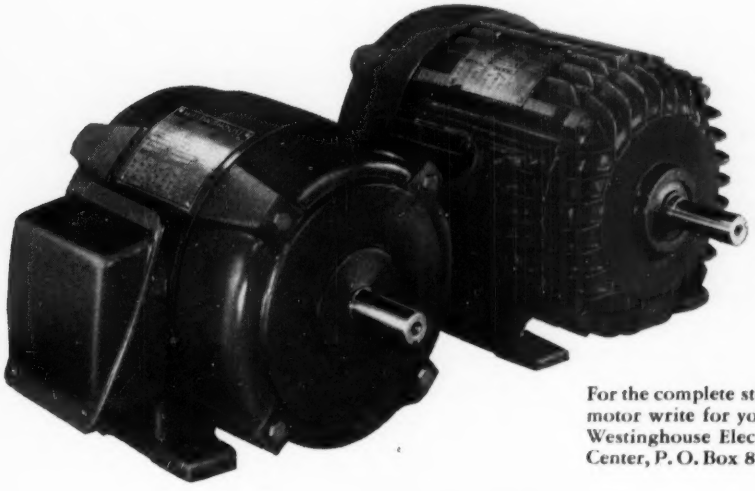
Copper, the other important active material, has not been sacrificed. The coil on the left is from an original Life-Line motor. The coil on the right is from a new Life-Line "A" motor. Both weigh the same.

Here's how more horsepower has been put in the Life-Line A motor

These demonstrations show how motor performance is determined by "active" material

Perhaps you are a motor user who has raised the question: "How can you shrink the size of a motor and still equal or better the original performance?" Let's look inside a motor to find the answer.

The performance of any motor is dependent upon its active material—the magnetic steel and copper. Take the original Life-Line® and the new Life-Line "A" for example. The amount of magnetic steel in the stator and rotor and the copper in the coils of both Life-Line designs are the same. The reduction in size has been accomplished by eliminating inactive material and space. Thus you have a smaller motor whose basic electrical performance remains unchanged. In fact, the Life-Line design principle has been proved in service for over seven years. J-21848



For the complete story on the new Life-Line "A" motor write for your copy of Booklet B-6154. Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa.

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Ranging to a depth of 500 ft., they represent six million tons of ore. Mining has already started.

How does your salary stack up?

With returns in on over 72,000 engineers—about 22 percent of all those employed in the U. S.—the Engineers Joint Council has prepared a comprehensive survey of engineering salaries in 1953 by industry groups. It's the first time such an extensive breakdown has been attempted by the Council.

To find out where you stand, both in relation to other members of your graduating year and to engineers in other industries, just glance at the table below:

Median Salaries for Engineers in 1953

Year of Graduation	Chemical and Allied Prod.	Petroleum, All Phases	Over-All Industry
1952.....	$4,455	$4,572	$4,284
1948.....	5,780	5,950	5,382
1940-1944.....	7,185	6,757	6,593
1930-1934.....	8,780	8,840	8,043
1920-1924.....	8,500	9,952	9,158

EJC also surveyed starting salaries last year. The average for chemical and allied products companies was $345 per month and ranged from $300 to $375. Petroleum companies were almost the same, the range being $315-$388, averaging $350. Overall industry had a much bigger range—$247-566—but the average, $341, was much the same.

New synthetic rubber industry blossoms

Although traditionally wedded to natural rubber, England has at last embarked on a synthetic rubber industry of its own. Three British companies have broken ground for plants with a total capacity of 17,600 short tons a year and more may follow. Production is expected in about two years.

Leading the parade was Imperial Chemical Industries, Ltd., with plans for an 11,000 ton unit to cost at least $3 million (see Chementator, May 1954). Following right behind were Dunlop Rubber Co., Ltd.—2,200 tons—and Monsanto Chemicals, Ltd.—4,400 tons.

Only Dunlop has come out and said its production will go into tires and tubes. ICI and Monsanto say their sales will go into such products as shoe soles and paints which don't threaten, directly at least, Britain's natural rubber interests.

Raw materials figure to be primarily domestic. ICI makes butadiene, is spending $14.8 million to boost output. Forth Chemicals, Ltd., in which Monsanto has substantial interest, is the only British styrene monomer producer and plans to double production. Acrylonitrile is not now in volume production by anyone in England, but ICI is expected to enter this field soon. Dunlop makes none of the raw materials, may have to import.

Oil from Iran? Don't hold your breath

Although oil talks that started recently in Iran will probably result in some kind of agreement that restores production of both crude and refined petroleum, they are likely to go on for months. At least that's the consensus of top oil people all over the world.

Hope for settlement rose when Iran finally agreed to talk with a newly-formed, eight-company Consortium. This consists of Anglo-Iranian, which would get 40 percent of the group's share of Iranian production, Royal Dutch Shell, 14 percent, Compaigne Francaise des Petroles, 6 percent and five American companies, 8 percent each—Std. Oil (N. J.) Socony-Vacuum, Std. Oil (Calif), Gulf and Texas Co.

But agreement to negotiate is just the first solution to a long line of thorny problems. These four major ones remain:

• How much control the Consortium will have over production, marketing and personnel. Iran, of course, wants this held to a minimum. The oil companies want virtually complete control.

• How long a lease Iran will grant. The group is reportedly seeking one for 25 years.

• How much compensation to Anglo-Iranian for loss of its properties in 1951, including the $1 billion refinery seized at Abadan. British Parliament sources indicate the bill will be about half a billion dollars. However, Iran may counterclaim as much as $1 billion for losses taken when Britain imposed an economic embargo on the country.

• How big a cut of the profits Iran will get. On this, one thing is practically certain, Iran will not get a bigger percentage that the rest of the Middle East countries now get—50 percent of the profits before taxes.

What are the chances of success? Good, but not imminent, say most authorities, although there's some concern about what will be done with Iranian oil if it becomes available. Here's a quick rundown on what the best-informed sources are thinking, both here and abroad.

UNITED STATES—Most oilmen agree that with demand growing rapidly in Europe—twice the U. S. rate—Iranian oil, both crude and refined,

(Continued on page 112)

If Sulfuric Acid is one of your Major Process Requirements

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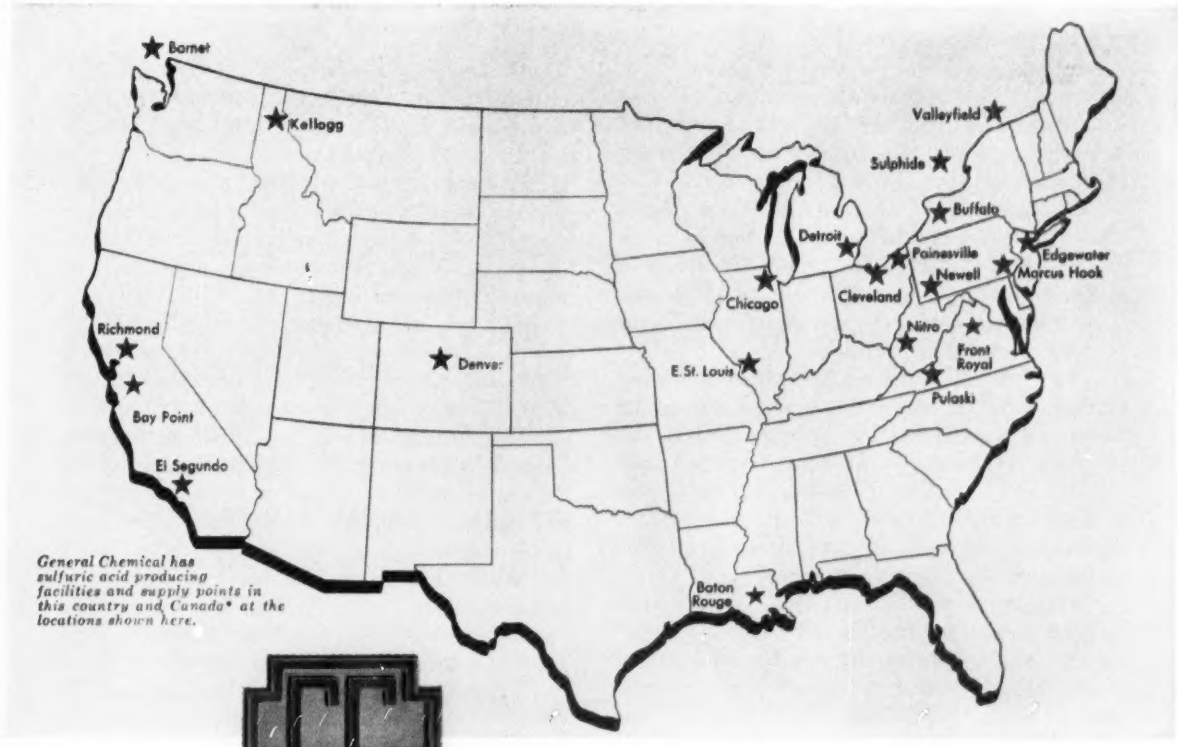

General Chemical has sulfuric acid producing facilities and supply points in this country and Canada at the locations shown here.*

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can be absorbed before too long. In 1951 Iran's crude production ran about 600,000 barrels per day, Abadan's refinery throughout, 500,000 bpd. And even if Iranian production is brought back to this level—practically an impossibility—the annual average increase in world consumption is just about 600,000 bpd.

ENGLAND—Selling and marketing Iranian oil, admittedly a problem, should not cause too many headaches. First, production will be slow in coming in. Second, neither crude nor refined oil output will be brought back to former levels in the near future, particularly since the Abadan refinery is badly corroded and will take months, plus $70-75 million, to repair.

FRANCE—Compaigne Francaise des Petroles has two major interests. One is to make sure that any Iranian oil coming to France can be paid for in francs in order to reduce the foreign exchange outlay. Secondly, of course, is the impact on the Iraq Oil Co., of which they are one-fourth owner. But presumably CFP is under the same governmental pressure as the other companies to do what it can to assist in reopening the flow of Iranian crude oil supplies.

NETHERLANDS—No undue disturbances of the world markets are expected. But Dutch sources believe that Iran will have to agree to a gradual reopening of its oil sluices, to a certain measure of international control and to foreign engineers.

These same quarters say that the Consortium's plan will probably entail a gradual Iranian crude production rise from 100,000 bpd. the first year to about 600,000 bpd. by the end of the fifth year. This will probably not necessitate curtailment in other Middle East countries.

MIDDLE EAST—It's believed here that enough additional demand can be developed for Iranian oil to make room for roughly 200,000 bpd. of crude production. However, an additional 200,000 bpd., which on a 50-50 profit split is what it would take to meet all of Iran's governmental expenses, would probably cause drastic production cutbacks on the Arabian peninsula.

One possible cushioning factor is that most Arabian crude is exported as such. If Iran's output can be sent largely to the Abadan refinery and markets can be found for refined products, competition with the Middle East would be considerably lessened.

Regulations tighten on use of 2,4-D

The State of Texas has banned the use of herbicide 2,4-D in seven Gulf Coast Counties, marking the first enforcement of the Texas Herbicide Law. And California is also contemplating more severe restrictions for the chemical.

Major reason is that 2,4-D is extremely damaging to some plants, particularly Texas cotton. Spraying the herbicide on crops that need it, like rice, often results in carryover to nearby fields of more sensitive crops.

But makers of 2,4-D although naturally unhappy about the ban, do not expect to lose much total business. Most of them make other herbicides, such as 2,4,5-T, methoxone, 2,4-D amines and esters, which not only fill the bill but are actually recommended as substitutes by state agriculture experts.

And practically all of these chemical companies, realizing that a problem exists, feel that the states are taking a realistic approach in their restrictions. Their really big problem now is that most of the substitutes cost more than 2,4-D and sizable re-education programs will be needed before farmers accept them.

Pollution: alarm and compassion

Air and water pollution—those thorny public relations problems of the chemical process industries—have received a bigger-than-normal play in this session of Congress.

Two viewpoints are apparent: alarm and compassion. Some of the bills introduced are attempts to prohibit both actual and potential pollution. Others are designed to encourage installation of pollution abatement equipment.

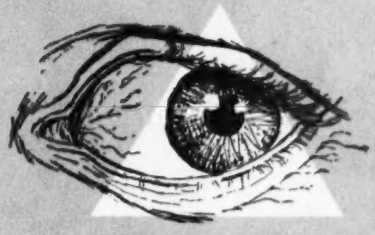
The only measure that seems to have much chance of becoming law, however, is of the second variety—the Capehart-Kuchel amendment to the Senate Housing Bill. This would give companies installing air pollution equipment full depreciation write-off in five years. In addition, it provides for FHA insurance of abatement equipment mortgages and allocates $5 million for federal-local research on air pollution.

While this amendment does not cover water pollution, many sources feel that if it becomes law similar action on water facilities in future years will be a good deal easier to get through.

Congress also held formal hearings on bills of the prohibitory kind, especially as relating to water pollution in the Lake Erie-Niagara River area. But with the push for early Congressional adjournment, these were given little chance from the time element alone.

What's Happening . . . page 114

Looking for GLYCERINE?



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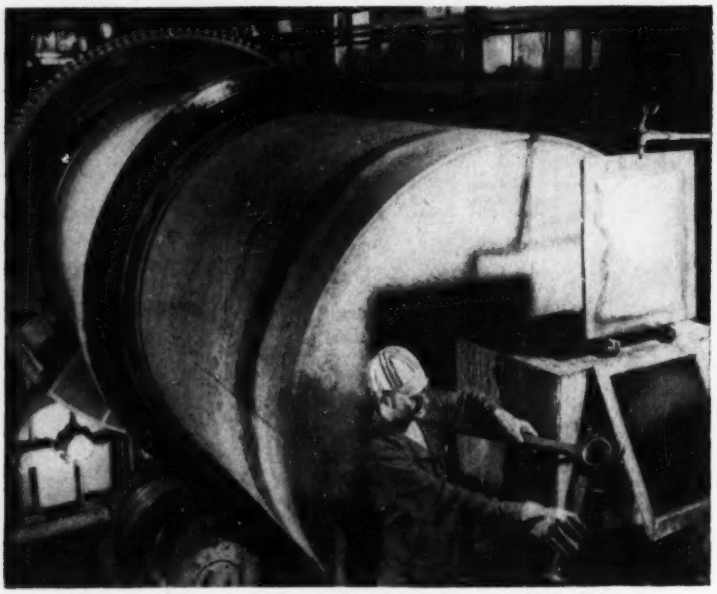


REDUCTION of chlorides in waste acid takes place in rotating drum.

Two Key Reactions Yield

SUCCESSFUL recovery of hydrochloric acid from tin leaching waste has finally solved a tough disposal problem, besides returning for reuse some 600,000 gal. per month of 31½ percent HCl.

Tin Processing Corp., which operates the government-owned tin smelter at Texas City, Tex., spent several years ironing the wrinkles out of the recovery process, the only one of its kind in the world.

▶ **Problem and Answer**—The spent-acid waste comes from the leaching of tin ores. It consists mainly of iron chloride and other metallic chlorides, plus 20 grams per liter of free HCl.

Prior to operation of the recovery plant, disposal of this waste was a major problem. It had been accumulating in 17 ponds covering 60 to 70 acres. This inventory of waste is now being gradually reduced along with disposal of waste from current operations.

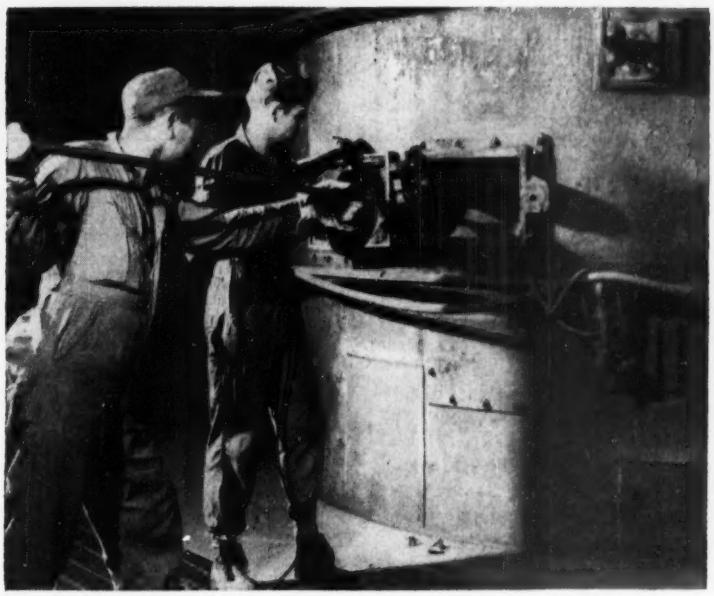
In addition to cutting new acid requirements in half, the recovery process also obtains as byproducts salable iron oxide and a mixture of

GAF Building Acetylene Derivatives Plant

More details are now out on the acetylene derivatives plant General Aniline & Film Corp. is going to build at Calvert City, Ky. (see *Chem. Eng.*, April 1954, p. 105). Operations are expected by the end of 1955; total cost will be $6 million.

Biggest production will be of the PVP family of acetylene derivatives, according to Jack Frye, president of GAF. These include pyrrolidone, methyl pyrrolidone, vinyl and polyvinyl pyrrolidones, propargyl alcohol, butynediol, butanediol and butyrolactone. Later, in a subsequent step, vinyl alkyl ethers and esters and their polymers will be made. These are now under sales development.

Construction and engineering are being handled by the Lummus Co., New York. GAF's Linden, N. J., pilot plant will continue to operate.



OXIDATION in four muffle furnaces produces iron oxide and HCl gas.

HCl From Tin Smelter Waste

metal compounds containing recoverable silver, copper and bismuth values. The latter product amounts to about 1½ tons per day; its silver content is 350 oz. per long ton.

▶**Process Highlights**—Briefly, the recovery process consists of these steps:

- Partially concentrated liquor reacts with iron turnings, reducing ferric to ferrous chloride and precipitating other metals.
- The precipitate is removed, dried and drummed for sale.
- Ferrous chloride crystals are obtained by further concentration and vacuum crystallization, then dried.
- The ferrous chloride is then roasted in muffle furnaces to get ferric oxide and HCl gas.
- The HCl gas is absorbed in water and returned to the leaching plant for reuse.
- Ferric oxide from the furnaces is quenched with water and pumped to settling ponds for recovery and sale.

▶**Reduction Step**—Reaction of metallic chlorides with iron produces ferrous chloride (in solution) and drops out arsenic, antimony, copper, bismuth and silver as "cements."

This step takes place in a horizontal steel drum lined with rubber and brick. The drum is 7½ ft. in diameter, 40 ft. long and slopes toward the discharge end at ¼ in. per ft. It rotates at approximately 1 rpm.

Liquor flows by gravity into the drum at a rate of 60 gpm. About 1,200 lb. per hr. of mild steel scrap turnings is also fed into the drum. The turnings have been previously freed of oil by burning in a rotary kiln. They are conveyed directly by a monorail hoist and electromagnet to the feed hopper, from which they are pushed manually into the reactor drum.

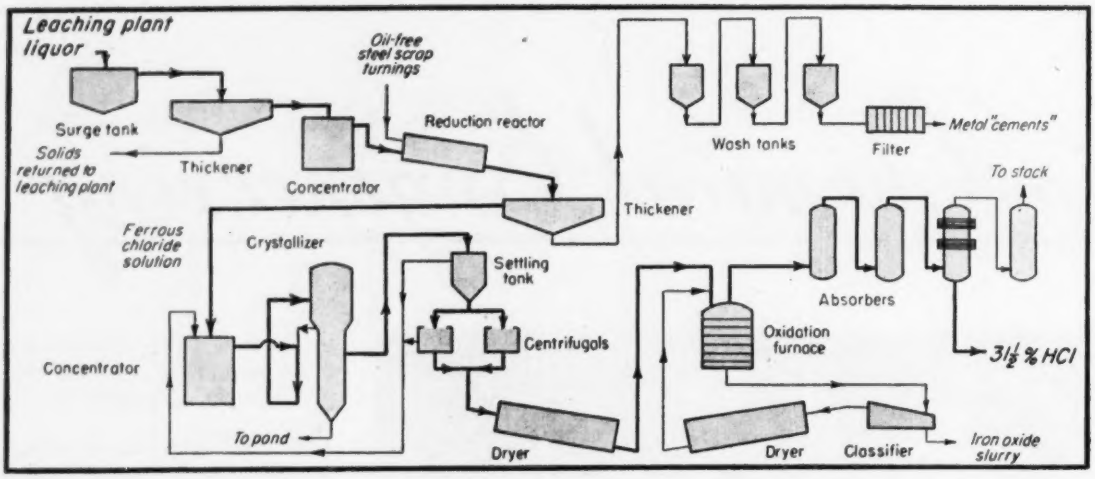
An exhaust fan carrying away the vapors maintains a negative pressure in the rotating drum at all times.

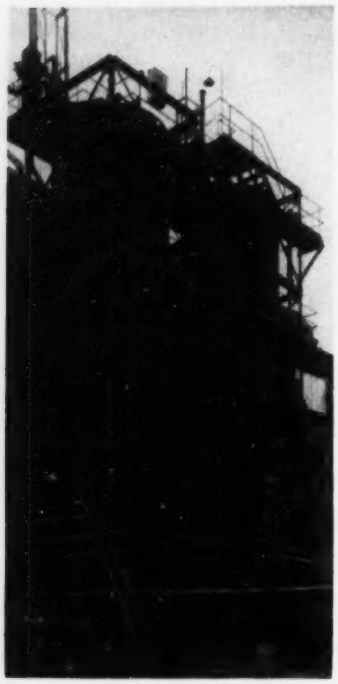
▶**Oxidation Step**—Production of HCl follows this reaction:

$$2FeCl_2 \cdot 2H_2O + \tfrac{1}{2}O_2 \rightarrow Fe_2O_3 + 4HCl + 2H_2O$$

The four muffle-type Herreshoff furnaces are each 12½ ft. I.D. with six hearths. Temperatures range from 700 deg. F. on the top hearth to 1,150 deg. on the bottom hearth. Furnace arms and teeth are of Pyrocast alloy, except for the fourth and fifth hearths, where the service is most severe — here Carbofrax teeth in Pyrocast holders are necessary.

Iron oxide calcine is discharged into a launder and flushed out with water. Part of the oxide is dried and recycled. HCl gas at a maximum of 900 deg. leaves the fur-





SCALE of operations is indicated by size of these vacuum crystallizers.

naces through insulated steel flues and passes through a dust settler on its way to the absorbers.

▶ **Unit Operations**—The two pairs of concentrators consist of 4,800-gal. rectangular tanks lined with rubber and brick. They operate under a pressure of 35 in. of water.

Evaporation is effected by three submerged-combustion burners in each tank; each burner generates 4.8 million Btu. per hr. This means of heating has proved to be very satisfactory.

Gases from the concentrators amount to 32,000 cfm. They are scrubbed in a Pease-Anthony scrubber with two venturi throats. Pressure drop across the throats is maintained at 25 to 27 in. water. Scrubbing liquor—about 6 gal. per 1,000 cfm.—is recirculated and maintained at a temperature above the dew point.

Thickening of the slurry from the reduction step takes place in a 35-ft.-dia. prestressed concrete tank with a 10-ft.-high vertical wall and conical bottom. Thickener mechanism is of the conventional continuous type. Underflow is washed countercurrently in three small rubber-lined thickeners.

Cements leaving the third wash thickener are filtered in a 36-in. recessed-plate filter press with iron plates and dynel cloth.

Crystallization of ferrous chloride from the hot liquor leaving the second set of concentrators is accomplished by adiabatic flash evaporation under vacuum, which cools the solution to the point of supersaturation. Crystals are formed and grow to 80 mesh or larger in the salt leg of the crystallizer. An elutriating flow in the salt leg classifies crystal size.

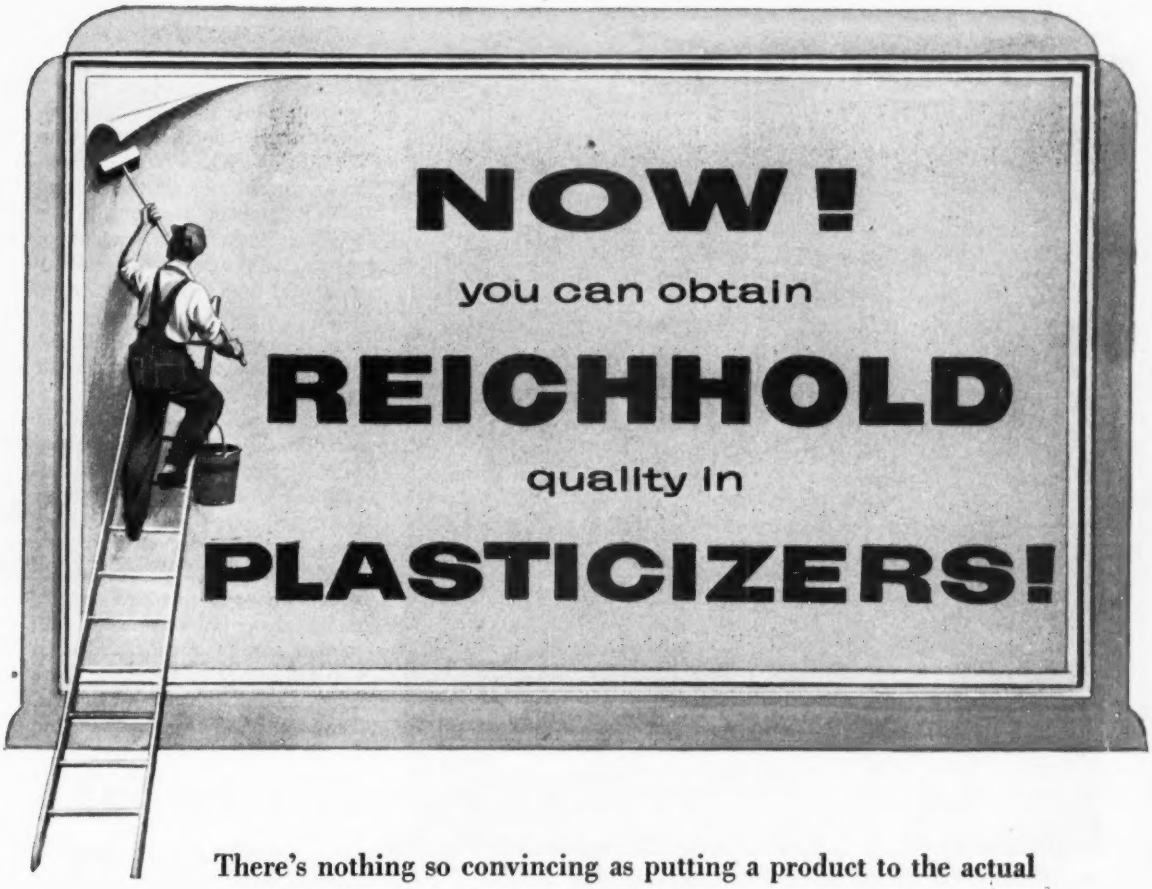
Crystals are centrifuged in four rubber-lined, bottom-discharge machines. Each basket holds 800 lb. of crystals; cycle time is 15 min. Crystals are $FeCl_2 \cdot 4H_2O$, with 3 to 5 percent surface moisture.

Two Roto-Louvre dryers evaporate the surface moisture and drive off two molecules of water of crystallization. There are two other rotary kilns—one for freeing the steel scrap turnings of oil, the other for drying recycled iron oxide calcine.

The HCl absorption system consists of four packed towers—the first for cooling and scrubbing, the second for condensing and stripping, the third for absorption and the fourth for scrubbing the tail gas. The absorption tower uses integral cooling. It is square in cross-section, made of Haveg. Banks of impregnated graphite tubes run horizontally across the tower, using the tower walls as tube sheets.

Several aspects of fluids handling are worthy of mention. Ferrous chloride solution from the first thickener is pumped to the second set of concentrators with a diaphragm pump. Acids are circulated in the absorption system by means of impregnated graphite centrifugal pumps.

Haveg pipe is used for hot acid, and polyvinyl chloride pipe is used where acid temperatures are below 100 deg. F.



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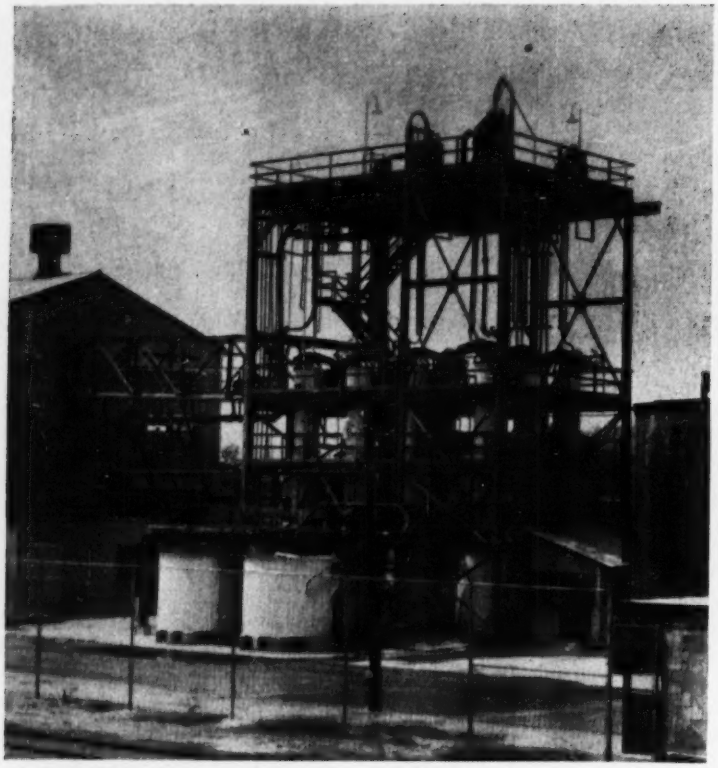

INTERNATIONAL MINERALS' new extraction plant yields . . .

More Uranium From Florida

AEC looks to further uranium recovery from now-discarded overburden as operations on commercially used phosphate matrix get into high gear.

Start-up of two more plants recovering uranium from Florida phosphate, marks the end of one phase of the Atomic Energy Commission's exploitation of this domestic source of fissionable materials.

The new plants—both in Florida—are those of International Minerals & Chemical Corp. at Bonnie and Virginia-Carolina Chemical Corp. at Nichols. Two other firms—Blockson Chemical Co., Joliet, Ill., and Texas City Chemicals, Texas City, Tex.—also recover uranium while processing Florida phosphate rock into fertilizer, animal feed supplement and chemicals. No other plants of this nature are now being built, although a number are under consideration.

▶ **Next, Leached Zone Rock**—Next big move on AEC's uranium-from-phosphate program is to explore the uranium-containing low-grade overburden known as "leached zone" material. This material, which contains 10 to 12 percent P_2O_5 in the form of aluminum phosphate, overlies the currently used high-grade phosphate rock "matrix" in beds 2 to 25 ft. thick.

The overburden can be concentrated by a simple sand-slime separation into a minus 200-mesh slime fraction containing more than 20 percent P_2O_5. New methods being studied increase the concentration to about 30 percent; this approaches the P_2O_5 content of commercially used matrix. Aluminum and iron content of commercial matrix is generally less than 5 percent, whereas these elements account for 10 to 20 percent of raw leached zone material.

Industry interest in the leached zone project is high. International Minerals has been operating a small pilot plant and studying possible processes for over two years. Other companies—some of whom obviously are interested primarily in the aluminum and fluorine values rather than phosphate—are Aluminum Co. of America, General Chemical, Virginia-Carolina, Texas City Chemicals and Blaw-Knox. Tennessee Valley Authority and the U. S. Department of Agriculture also are making studies of extraction processes and conducting agronomic tests.

▶ **Uranium Potential**—Although both raw matrix and raw aluminum phosphate material contain only minor concentrations of uranium—0.1 to 0.4 lb. U_3O_8 per ton—the tonnage mined each year make these materials huge potential sources of uranium.

Quoting AEC figures for 1952, more than 25 million tons of raw matrix was mined in Florida that year, from which an estimated 14 million tons of leached zone material was moved and discarded as waste.

This 39 million tons, even at the lower limit of concentration, contained about 4 million lb. of U_3O_8. With a reserve of a billion or more tons of matrix, plus another billion tons of leached zone material, this country should have a steady supply of uranium for 100 years from this source alone. This prospect will certainly give neither aid nor comfort to potential enemies!

In addition to these Florida reserves, the large formations of commercial phosphatic materials in Utah, Idaho, Wyoming and Montana have barely been tapped.

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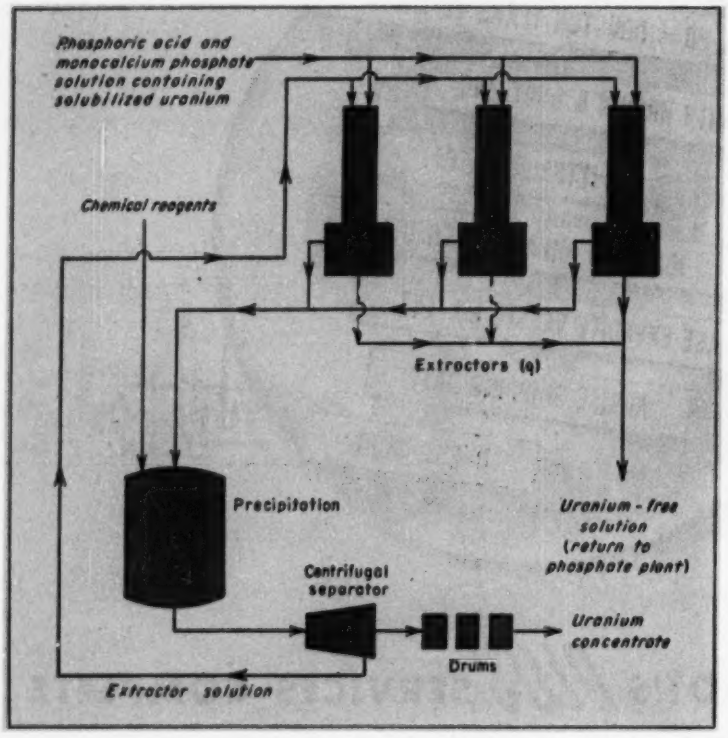


Rapid growth of the Western phosphate industry will compound the quantity of uranium available via new recovery processes being developed.

▶ **Operations at Bonnie**—Although there are several possible methods for getting uranium out of phosphatic materials, the process used by International at Bonnie— and also by Virginia-Carolina at Nichols —involves leaching of superphosphate (either cured or uncured) and solvent extraction of the leach solution, followed by chemical precipitation of the extracted uranium.

The entire stream of phosphatic materials entering the Bonnie plant goes through this process. Based on reported plant capacity for producing feed and fertilizer phosphates, U_3O_8 recoverable by this single facility is estimated to be in the range of 60,000 to 160,000 lb. per year. In fuel value this is equivalent to a large coal mine.

Process details are still under wraps. Just what reagents are used for leaching, extraction and precipitation belong in the realm of classified information. All that can be said about the uranium yield is that it is "of a high order of magnitude."

Solution from the leaching step in International's plant is fairly clear, containing phosphoric acid, monocalcium phosphate and "solubilized uranium." Extraction takes place continuously in nine rubber-lined agitated vertical contactors operated in parallel. The contactors are some 3 ft. diameter and about 20 ft. high.

Final uranium concentrate, a chemical precipitate that also contains rare earths, comes from the centrifuging operations as a light-green crystalline product. It is shipped in drums to AEC processing plants.

IMC President Louis Ware points out that uranium operations at Bonnie are in no sense a financial bonanza. IMC expects to recover its capital in ten years (75 percent of it in five years via accelerated amortization) and will make only a "modest profit" on the uranium concentrate sold to AEC.

Water Purified Safely With Silver Salts

Salem-Brosius, Inc., Pittsburgh, has adapted a European water purification method to American needs. Called the Hyla process, it is a catalytic technique that uses complex silver salts deposited on a common carrier material.

Tests by Johns Hopkins University show that 90 percent of the bacteria in water are killed in 10 minutes, ninety percent of the remaining bacteria in the next 10 minutes and so forth. Residual disinfecting action of Hyla lasts as long as any silver remains in the system.

The ability of silver to purify water, although known for years, has been handicapped by inability to maintain complete and precise control of the amount of silver imparted to the water. The Hyla process overcomes this, leaves less than one percent of the safe amount determined by the U. S. Public Health Service—one part of silver per million parts of water, according to Salem-Brosius.

Convention Calendar

Chemical Specialties Manufacturers Association, mid-year meeting, Netherlands Plaza Hotel, Cincinnati, May 23-25.

American Society for Testing Materials, annual meeting of Committee on Mass Spectrometry, Jung Hotel, New Orleans, May 24-28.

Manufacturing Chemists Association, joint meeting with Synthetic Organic Chemical Manufacturers Association, Greenbrier Hotel, White Sulphur Springs, W. Va., June 3-5.

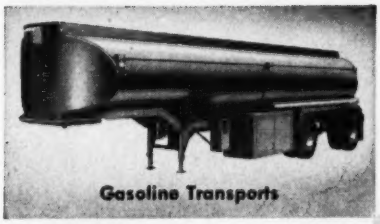
The Society of the Plastics Industry, National Plastics Exposition, Public Auditorium, Cleveland, June 7-10.

National Society of Professional Engineers, annual meeting, Schroeder Hotel, Milwaukee, Wis., June 9-12.

National Fertilizer Association, symposium on granulation, Greenbrier Hotel, White Sulphur Springs, W. Va., June 15.

American Institute of Chemical Engineers, special meeting on nuclear energy, including exposition of "Atoms for Peace," University of Michigan, Ann Arbor, Mich., June 20-25.

GREATEST LINE IN TANK-TRAILER HISTORY!



Gasoline Transports

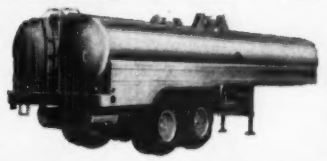
Here are just a few Fruehauf models

Wherever, whenever, there's a liquid-hauling job to be done, there's a Fruehauf Tank-Trailer specially designed to do it *profitably!* Fruehauf's line of Tank-Trailers is the broadest, the finest, in the Trailer industry!

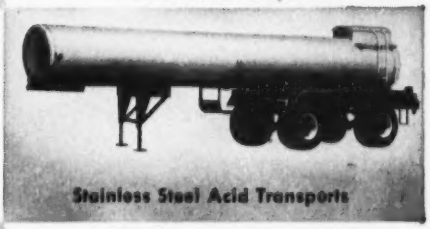
Western Truck-Full-Trailer Gasoline Combinations

A Cutaway View of the Gasoline Transport

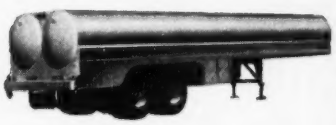
Fuel Oil Tank-Trailers



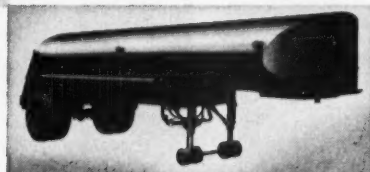
Twin-Cylinder Casinghead Transports



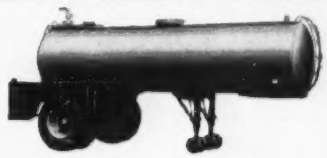
Stainless Steel Acid Transports



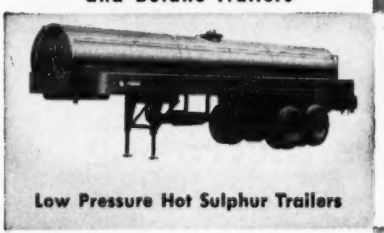
Twin-Cylinder Propane and Butane Trailers



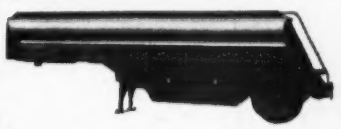
Stainless Steel Alcohol Tank-Trailers



Plastics Transports

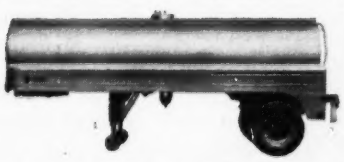


Low Pressure Hot Sulphur Trailers



Solvents Transports

Truck-Tanks



Low Pressure Latex Tank-Trailers

Carbon Steel Insulated Acid Trailers

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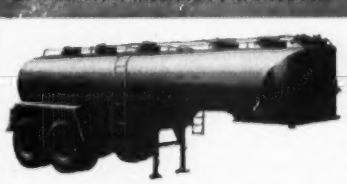
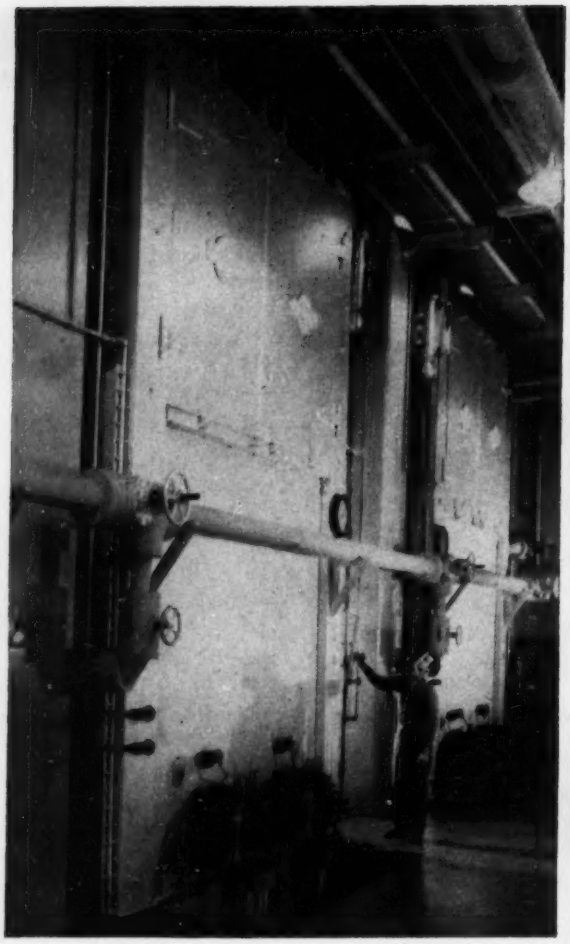
Formaldehyde Transports of Plastic Construction

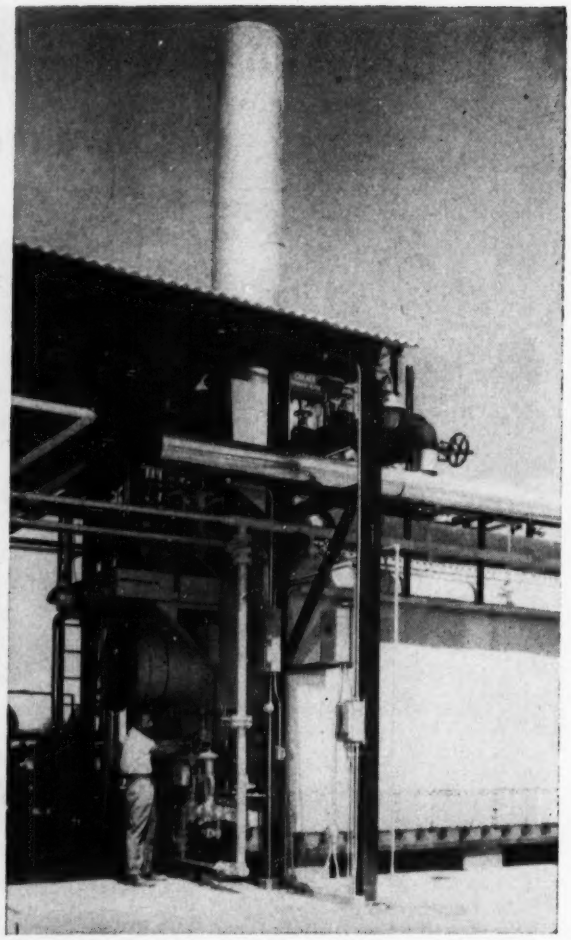


Calcium Chloride Transports

For complete information on Fruehauf's full line of Tank-Trailers, or about any specific unit for your business, call your nearest Fruehauf Branch or write to Fruehauf Trailer Company, 10969 Harper Avenue, Detroit 32, Michigan.



CENTRAL POWER PLANTS are still widely used, but . . .



PACKAGED UNITS are rapidly finding favor for special uses.

Use of Packaged Steam Generators Increasing

The swing to packaged steam generators both to supplement and substitute for a central boiler room is a chemical industry trend. Convenience and flexibility are features.

If you've been in many chemical plants lately you're probably well aware of the trend toward the use of more and more packaged steam generators. From Jacksonville to Tacoma, from pharmaceuticals to heavy chemicals, an increasing number of chemical makers are turning to these units for process steam and building heat.

One generator man estimates that his company alone has installed enough units to produce well over 2 million lb. of steam per hr. Nobody would even guess at the entire market.

▶**How They're Being Used**—A CE survey, in which we talked to men in chemical plants throughout the country, reveals that packaged steam generators have caught on in nearly every phase of the industry.

You'll find them in Florida fish oil plants and in heavy chemical plants in Washington.

However, if the plant has a constant or high steam demand, a central unit, tailor-made for the job, is generally preferred. For instance, in a California chemical plant a central unit was chosen because of steady, high steam requirements, and to get the "built-in" overload capacity inherent in central units along with

in CANADA as elsewhere throughout the world

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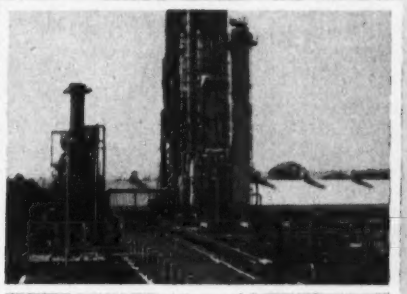
are most efficient by any comparison



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Simplicity of Design and Construction
are Petrochem-Isoflow design factors which provide
operating performance most efficient by any comparison.

The Isoflow Heater basically is a circular steel shell; this results in an explosion-resistant structure. The shell is lined on the inside with insulation and insulating refractories; this results in a wall with a zero air leakage and high efficiency. The vertical tubes are combined with integral convection tubes; this results in less headers in the heaters for complete cleanability. The integral radiant convection tubes and minimum number of headers result in a minimum pressure drop for a given velocity. The vertical tubes completely shield the walls resulting in low wall maintenance. The small number of headers in combination with the vertical tubes result in ease of cleaning and, if desirable, gang-cleaning of several tubes simultaneously. Individual burners, symmetrically spaced with relationship to the tubes, results in even heat distribution horizontally. The reradiant cone effects even heat distribution vertically. Segregated burners result in ease of firing and inspection of burners. These are some of the design features which place Isoflow Furnaces in a class of their own.

More than 1200 are in operation throughout the world in the petroleum, chemical and allied industries . . . for all processes and for any duty, pressure, temperature and efficiency . . . and all Petrochem-Isoflow Furnaces are pre-eminently satisfactory.

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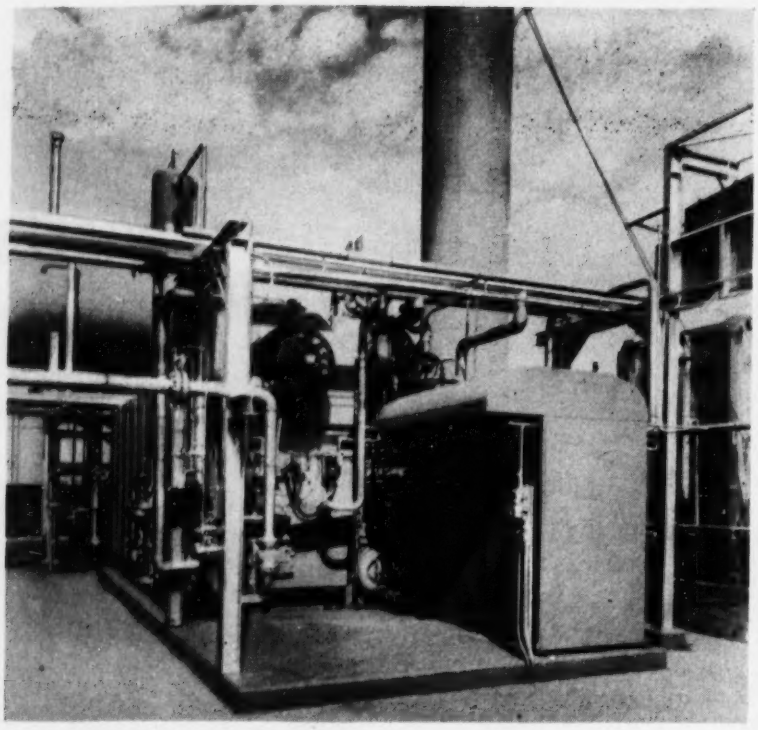

OUTDOOR installation of packaged boilers is often practical.

easier quality control of the water. The same company, however, picked packaged units for two smaller plants some distance away.

Again out on the West Coast, another chose two 25,000 lb. per hr. units to deliver process steam at 150 psi. The reason: need for flexibility under intermittent and varying steam demand.

Down in Texas packaged boilers are used in both chemical plants and, from time to time, in refineries. For temporary use the units are often rented.

In Texas, getting sufficient, properly treated water often poses a problem. The units can, however, be operated successfully on condensate up to any pressure.

Pharmaceutical plants are among the biggest users of the self-contained units, since their inherent flexibility and quick start-up characteristics fit them perfectly for the batch operations of that industry.

Other companies are using them because they have found that some phases of their process operate more efficiently and economically with higher steam pressures and temperatures than the central plant will deliver. Packaged units may even be obtained with an integral superheater to boost the temperature still higher.

► **Characteristics**—A packaged steam generator is a completely assembled and instrumented, pretested unit—shipped ready-to-install. Installation is quick and simple, usually requiring only water, fuel and electrical connections.

Packaged units may be portable or stationary. The portable types have found wide acceptance in the construction industry and in the oil fields.

Just as with conventional steam boilers, self-contained units may be of either firetube or watertube design—hot gases may be confined to the tubes, or the water may be placed on the tube-side and the gases passed around them.

You can get firetube units with any rated capacity from 500 to 17,250 lb. of steam per hr. (212 deg. F.) and with operating pressures ranging from 10 to 600 psi.

Watertube designs will furnish up to 35,000 lb. of steam per hr. (212 deg. F.) at operating pressures from 25 to 900 psi.

► **What They Offer**—What advantages does the packaged unit offer the user? Principally, flexibility. Where the big, tailored-to-the-job central power plant is fine for a heavy, even load, the characteristics of the packaged unit—automatic control, quick startup, high thermal efficiency at nearly all levels of capacity—fit it for handling a fluctuating or an intermittent steam demand.

Often, a battery of two or more units is installed to cover a wide variation in demand. And, occasionally, you'll find a small unit being used to supplement the central station.

Convenience is another factor in its favor. The packaged unit comes already assembled (one manufacturer supplies units from 40,000 to 100,000 lb. of steam per hr. which are assembled on the job site—others in the field feel that these really aren't packaged units) and is easily installed—special foundations are not required and necessary connections can be made in a minimum of time. This generally places the cost of installing the unit a good deal below that for a comparable unit, tailored to the plant.

Many types of packaged units feature fuel convertibility—from oil to gas, and some will even burn powdered coal. This enables the user to profit by burning the cheapest fuel at a given time. High thermal efficiency, generally over 80 percent, also slices costs.

The units are especially handy for remote locations. Maintenance is low and in most cases the manufacturer can provide service within 24 hours. About the only problem in a remote location is adequate water treatment. Condensate return will reduce water requirements, but, as with all steam generators, an adequate supply of soft, properly treated water is essential to trouble-free operation.

In the plant the compactness of the packaged units is a space-saver. It eliminates the need for a special boiler room. Many installations are made out-of-doors, and one user has installed a unit atop a railroad flatcar and moves it within the plant, and even from plant to plant, as it is needed.

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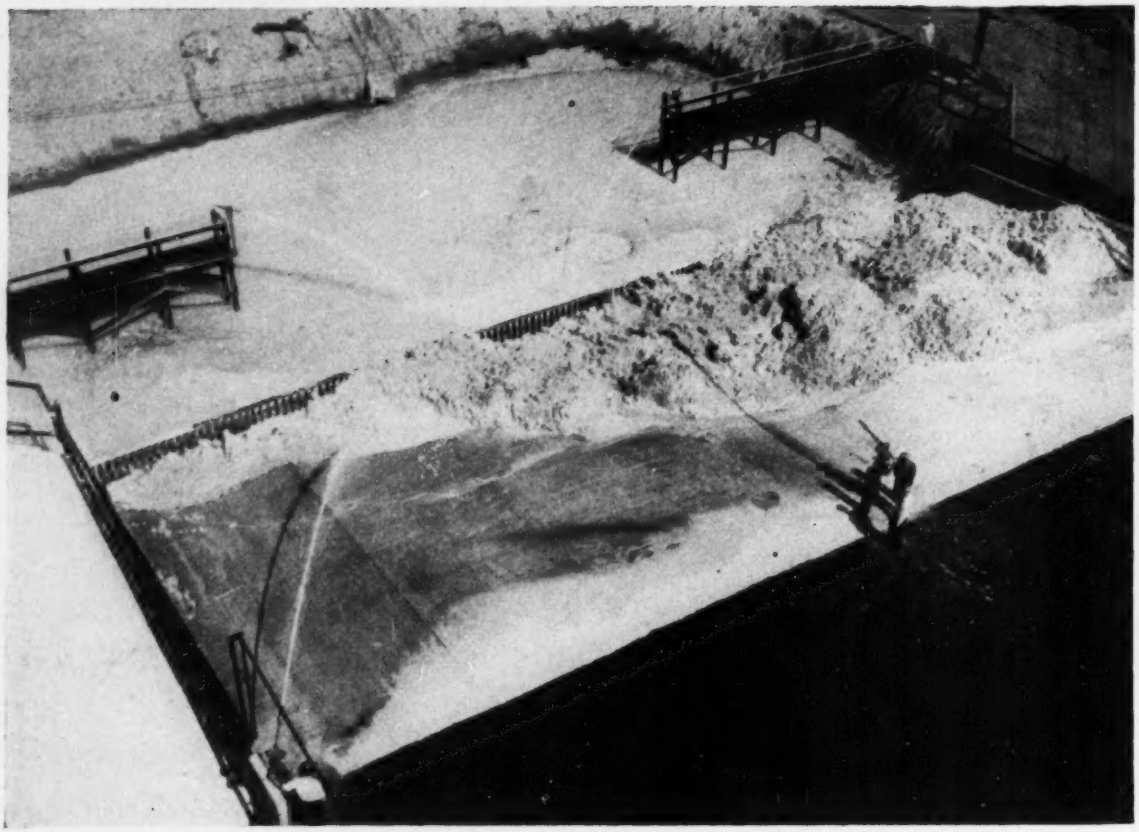


Jetted Lime Sludge Works on Waste

A little over a year ago, Du Pont's Chambers Works put in a railroad track and a storage silo for adding pebble lime to its Deepwater Point effluent. Soon after, an engineer came up with the idea that lime sludge (free for the hauling) could be used. Old system now on standby as these new jets get steady work. →

Late last year, the Du Pont Company adopted a new method for neutralizing run-off water at Deepwater Point, N. J. According to the Chambers Works Power Div., which has the responsibility for controlling waste water effluent, the new method using byproduct lime sludge for neutralization will be equally effective as adding pebble lime solution and less costly.

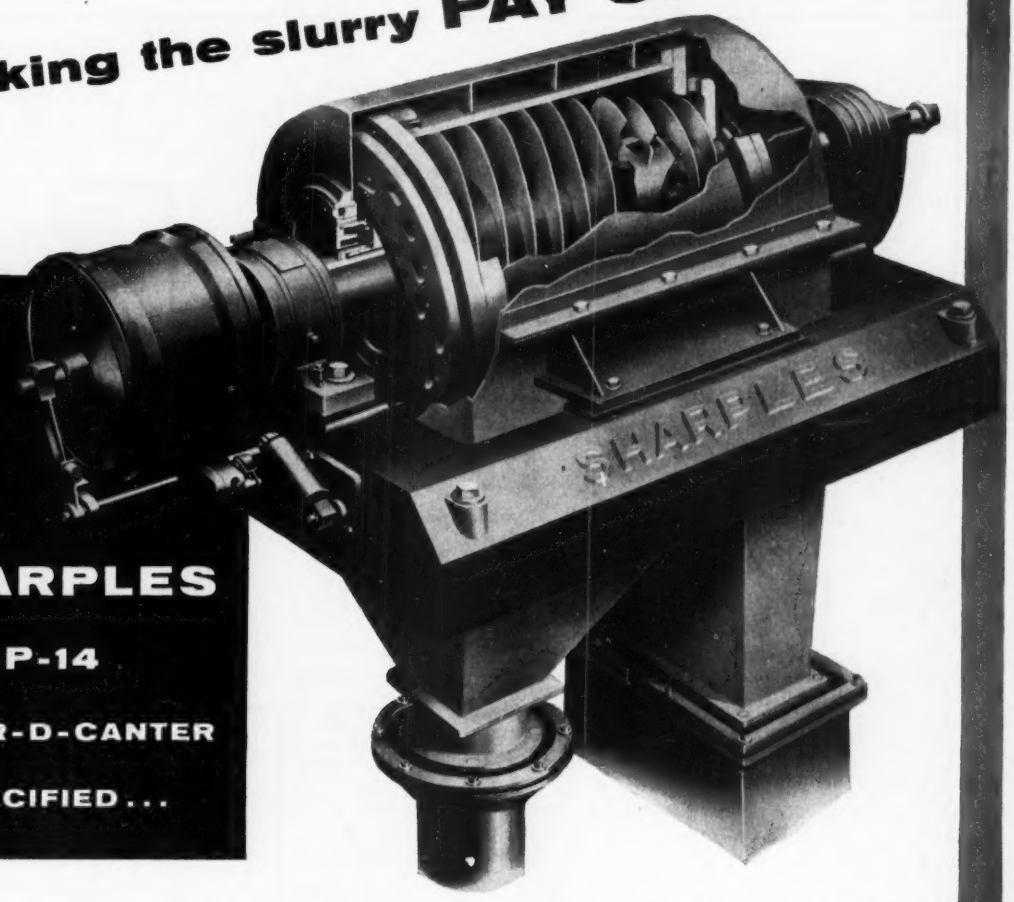
All water from the Chambers Works is conveyed to an impounding basin. After neutralization and settling, the purged water is then sluiced into the Delaware River without detrimental biological effects. A silo-like plant had been built to make solution from pebble lime.

But there is an abundance of byproduct lime sludge available from acetylene manufacturing operations within reasonable transporting distance. And it is practically free for the hauling away.

When one firm agreed to supply the sludge Du Pont installed a 40 × 100 ft. lime-sludge apron and a series of water-jet nozzles to sluice the sludge into a reservoir. The resulting lime solution is then pumped into the waste stream around-the-clock.

Approximately 150 to 200 tons of the sludge is trucked in each day from points such as Elkton, Md., and Bound Brook, N. J. However, the pebble lime plant equipment is kept on a stand-by schedule and used on weekends when no sludge is trucked.

making the slurry PAY OFF



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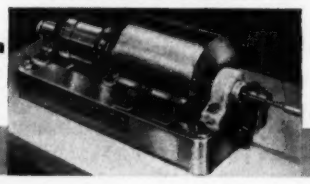
It will pay you to check into the extra profits that may be derived from your slurry. The Sharples Super-D-Canter is described in detail in Bulletin 1254.

THE NEW P-4 SUPER-D-CANTER FOR PILOT PLANT USE

Bulletin 1275



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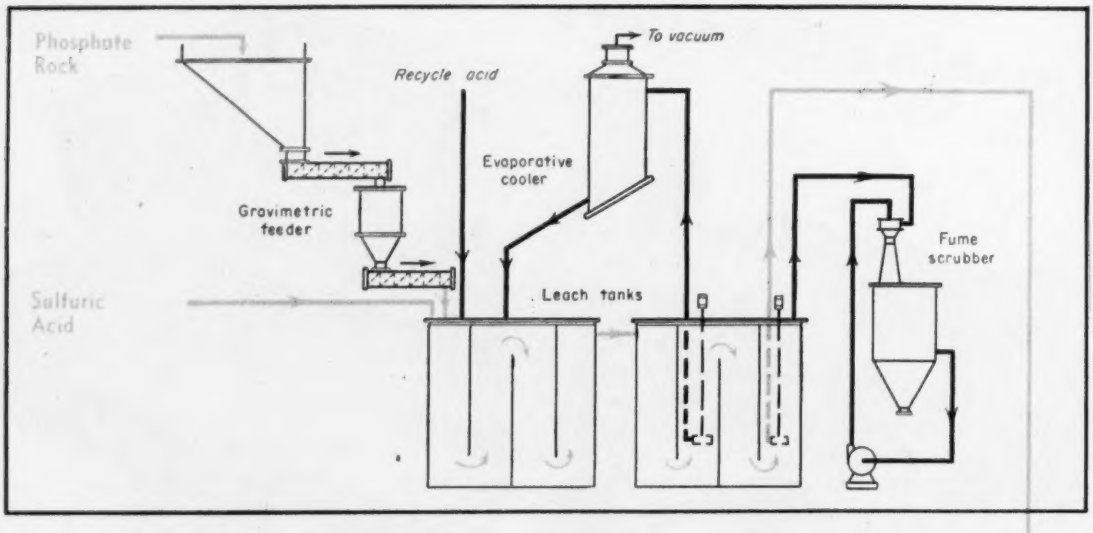
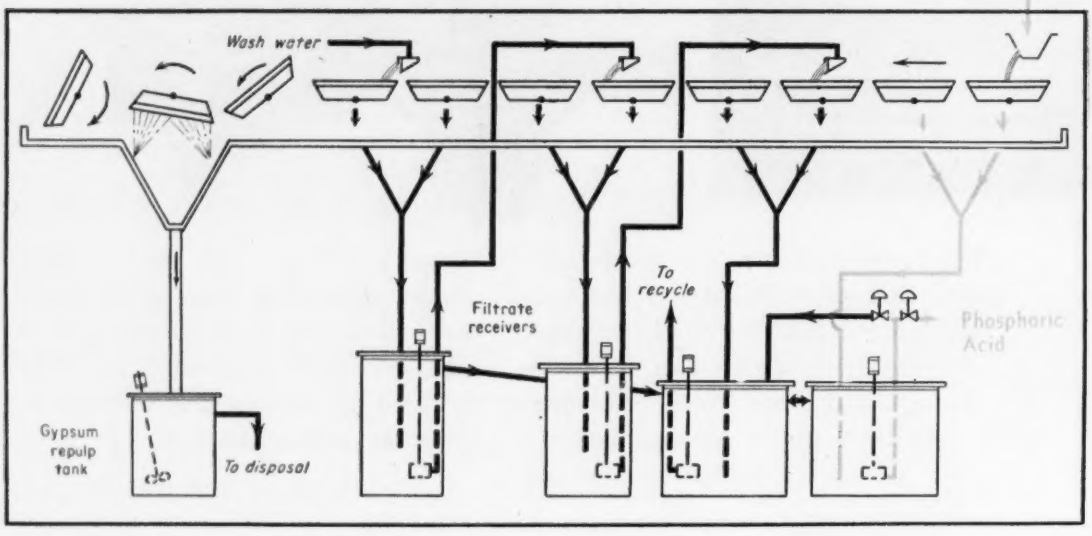


New Phosphoric Acid Plant . . .



Uses Novel Rotating-Tray Filter

Two days after starting up with cold water and phosphate rock, Smith-Douglass' new wet-process phosphoric acid plant at Streator, Ill., was in full production at good strength and yield.

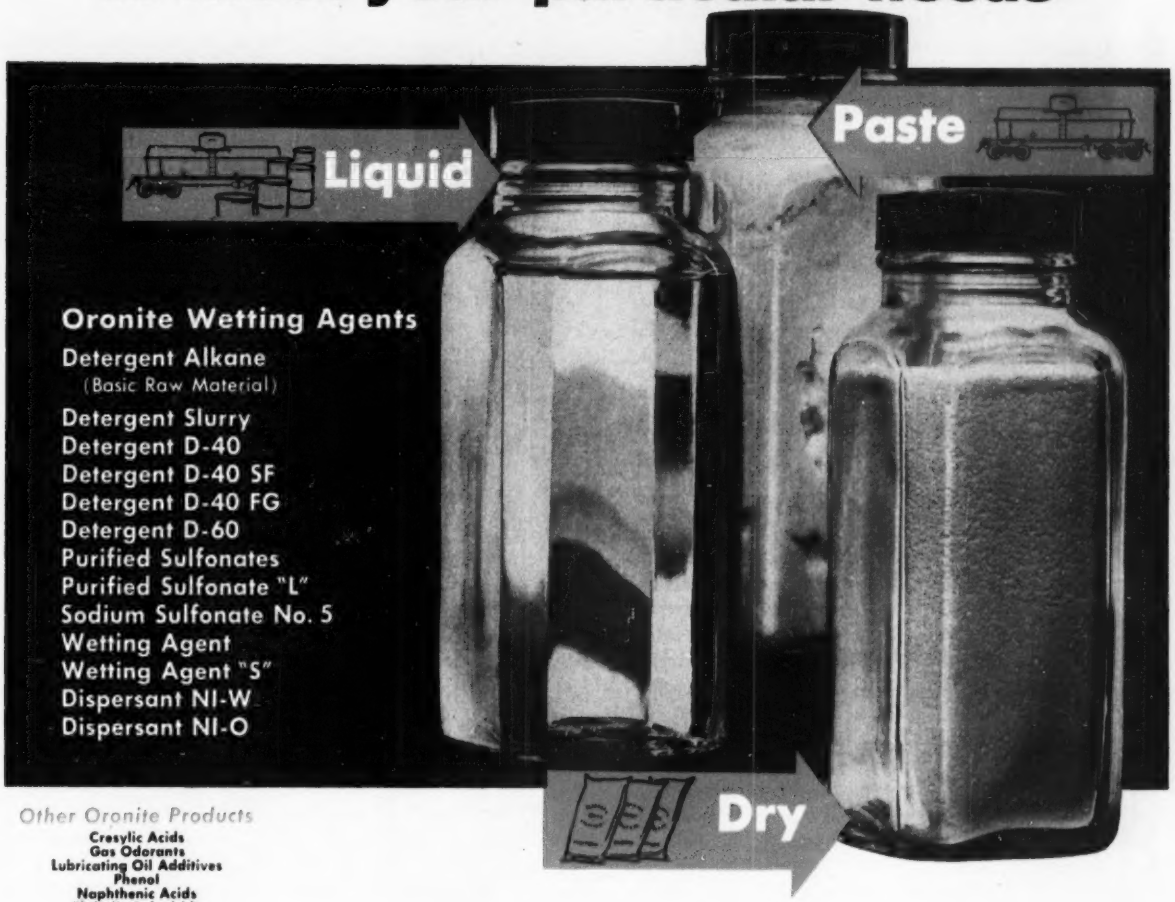
This feat is especially noteworthy in that the plant is the first in this country to use the Belgian Prayon process.* Credit for this accomplishment goes to the cooperative efforts of Smith-Douglass and Singmaster & Breyer, New York engineering firm who designed and managed construction of the plant.

► **Process Features** – Equipment-wise, outstanding feature of the new plant is the novel filter which ef-

*Western Phosphates, who started up its Garfield, Utah, plant on January 14, 10 days ahead of Smith-Douglass, uses Prayon's filter, its own process.

wetting agents

to meet your particular needs



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2870

COMPARTMENTS in leach tanks have their own individual agitators.

ficiently removes calcium sulfate from the phosphoric acid product. This filter is a horizontal, rotating machine, 28 ft. in diameter, with 15 individual trays.

Processwise, the new plant boasts several distinctions:

- Yield consistently runs better than 95 percent of acid containing 30 percent P_2O_5.
- Water economies effected by the special filter make possible a 32 percent product from sulfuric acid as weak as 55 percent.
- Evaporative cooling of a recycle acid stream drops leaching temperatures to 145 deg. F.–15-20 degrees cooler than conventional processes. This eases considerably corrosion problems, permits use of rubber-lined steel instead of lead.
- Antifoam agents are usually unnecessary when the leach system is operated properly.

▶ **Leach System**—Fundamental chemistry of the process is the same as for all wet-process phosphoric acid plants. Finely ground phosphate rock is slurried with recycled phosphoric acid, then reacted with sulfuric acid to precipitate gypsum ($CaSO_4 \cdot 2H_2O$).

Smith-Douglass uses an eight-compartment leach system consisting of two 17-ft.-dia. tanks. Each tank is divided into four quadrants by vertical baffle walls made of acid-proof brick bonded with furan resin cement. The compartments are interconnected alternately at top and bottom; each one has its own agitator.

Leach system temperatures must be held at the optimum level for growth of large, easily filtered gypsum crystals. Control is provided by a vacuum evaporator through which the leach slurry is pumped in sufficient volume (U.S. patent applied for). A Nash pump pulls a vacuum of 25 in. Hg.

An obnoxious-vapor condenser scrubs out fluorine-containing fumes from the leach system.

▶ **Novel Filter**—Slurry, pumped from storage in the final two compartments of the leach tanks, is fed to a tray at a point of no vacuum on the Prayon filter. Filter rotation—about 5 revolutions per hour—carries the tray to an area of vacuum where product acid is removed. The gypsum cake is washed successively with two truly countercurrent washes of recycled dilute acid and one of water. The four stages of filtration subject each tray to vacuum for 96 deg. of the rotation. Wash waters also are returned to the leach system.

After the cake has been washed free of acid the tray is overturned and a blast of air discharges the cake to the repulp tank, where it is slurried and sent to a disposal pond. Blinding of the filter cloth is minimized by washing it with a jet of water. The washed cloth is dried with vacuum to eliminate dilution of the product acid with wash water. (For details of filter design and construction, see p. 296.)

Phosphoric acid plants using the Prayon process need only one filter. According to R. L. Somerville, Singmaster & Breyer's project engineer, downtime is so short that provision of a spare is unnecessary.

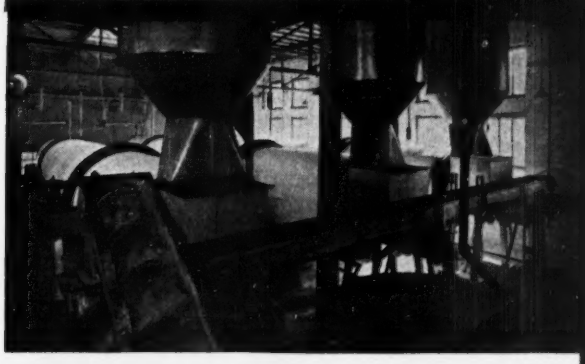
The filter runs with a very small amount of attention or maintenance, reports Smith-Douglass. It is out in the open where it is easy to work on and can be watched in operation. In most plants a good part of the operation is under cover and cannot be observed by the operator or supervisor.

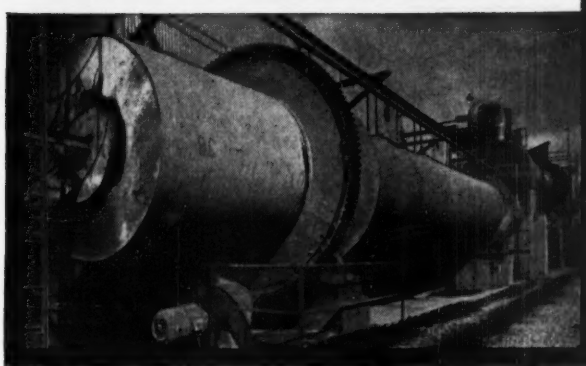
▶ **Materials of Construction**—Because of successful temperature control, rubber-lined steel for equipment and rubber hose for piping are satisfactory. Some equipment parts are of Type 316 stainless steel and Durimet 20. Two Belgian alloys—HV 7 and HR 5—have shown excellent resistance to phosphoric acid.

The 6-in. line carrying repulped gypsum to the disposal pond is made of polyethylene plastic. It floats on the surface of the pond without support, simplifying distribution of the gypsum.

Because the plant is simple and the process easily controlled, only a few control instruments are necessary. A gravimetric feeder controls the flow of phosphate rock to the leach system. A recording controlling rotameter governs sulfuric acid flow. There are several solid and liquid level controls.

more than 50 years of experience in designing and building dryers for industry...





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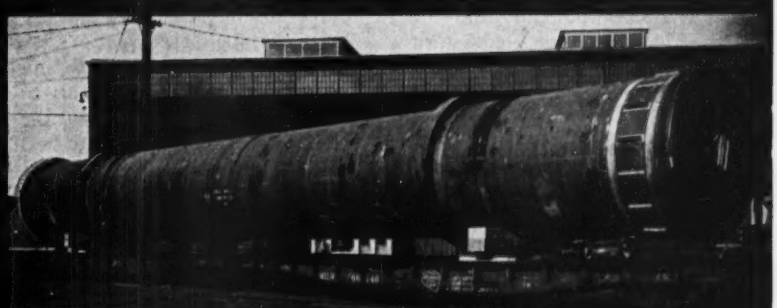

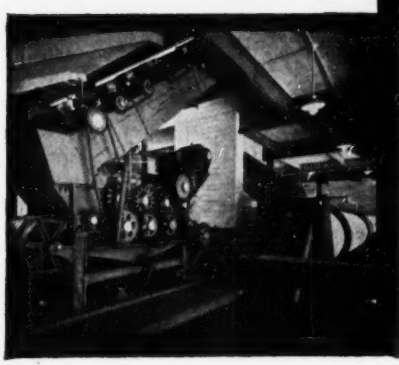

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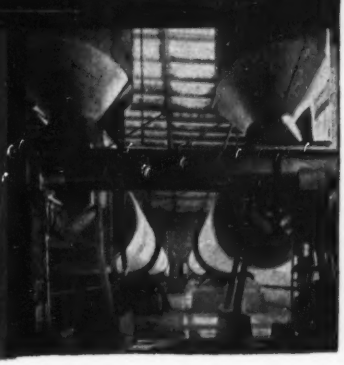
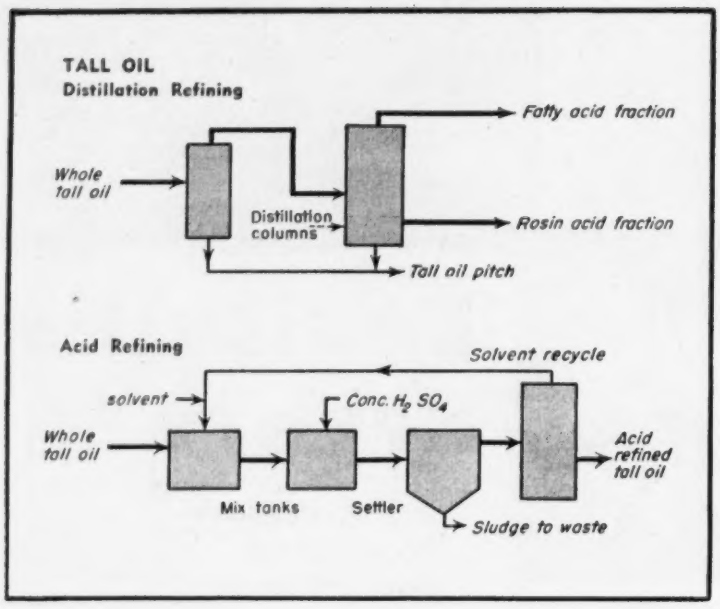
Louisville engineers will test your dryer needs in our laboratory. When required, a pilot model will be checked in your plant before full-size dryers are built.

Louisville's creative engineering pre-determines results for you!





From Byproduct to Big Product

That's the tall oil story. A decade ago you could total its uses on your fingers. Then they began refining it. Now, plants are expanding and business is booming.

When Newport Industries, Inc., came on stream last month with a new $2.7-million tall oil processing unit at Bay Minette, Ala., it marked the third expansion of facilities in the industry within recent months.* And with Arizona Chemical's recent announcement that by mid-1955 it will have expanded its refining and separating facilities at Panama City, Fla., by some 250 percent, it's a sure sign that tall oil is coming of age.

It's another case of a wallflower blossoming into the belle of the ball. For years wood-pulping mills tried just about every way they could think of to get rid of the foamy black-liquor skimmings produced in the kraft pulp process. Foam-clogging of equipment presented a real problem to them, and foam tanks and foam breakers to the contrary, they decided that the best way to lick the problem was to skim off the foam before it caused trouble.

▶ **Now Paying Off**—Since there was not much of a market for the skimmings, they burned it, buried it and dumped it into nearby streams —until the neighbors started to kick. Then they set their researchers to the task of developing new uses and new refining methods. Now the dividends are beginning to roll in.

Some of these dividends may even be rolling your way, if your process is one that's been able to use tall oil to advantage. For a number of industries already are doing just that. Soap makers, for instance, have found that adding rosin to soap improves foaming properties. With tall oil they have saponifiable fatty acids with a built-in rosin content. In the same way makers of adhesives, linoleum, greases, flotation agents, paints and a host of other products are including tall oil in their formulations.

First move of the researchers assigned to delve into the technology of tall oil was to study the work of a number of Swedish chemists. They found that the oil had already proved its worth in a number of applications, both in Sweden and throughout Europe. It seemed clear that a good market for tall oil could be evolved here.

With a great many uses already developed, research in the U.S. took a somewhat different tack.

No matter which market it entered tall oil was sure to find competition from an abundance of other raw materials. While tall oil —already an almost unwanted byproduct—had an immediate price advantage, it also had many disadvantages: objectionable color, unpleasant odor, variable composition, etc. These can be overcome only by refining.

▶ **Converting the Skimmings**—Since the skimmings as such have few uses, the first step in the tall oil refining process is to convert it into the oil.

As it comes from the pulp mill, the black liquor skimmings is a foamy, soapy substance. After settling, this material is acidified with sulfuric acid and the acidified mixture heated to convert the sodium soaps produced in the pulping process into whole tall oil—a mixture of free rosin and fatty acids.

The reaction mixture is again settled and a clear, brown oil separated from the sodium sulfate solution and from the lignin and other impurities.

About a dozen pulp companies, and a number of chemical firms who buy skimmings from the mills, carry out these operations. Their combined production of whole tall oil topped the 175,000-ton mark last year—quite an increase from the 10,000 tons recovered in 1937.

* Early last year Crossett Chemical Co., Crossett, Ark., placed on stream a plant to turn out 6,000 tons of whole tall oil per year. Late last year, Cactus Chemical Co., Houston, Tex., officially began operations at its new tall oil refining plant.

Where *is "Lead" used to control Sulphuric Acid Corrosion?*

Find H_2SO_4 and you're apt to find lead.

Lead's fought H_2SO_4 corrosion for several centuries and its usefulness grows steadily.

The past few years have seen lead go into new types of electrostatic and sonic air purifiers; into new waste treating equipment; bubble towers; devices for processing, recovering and storing sulphuric acid and other chemicals.

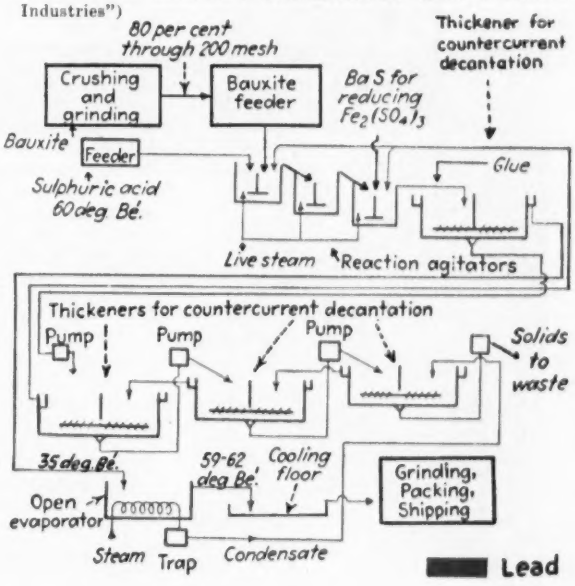
And new forms of cage-type sheet lead structures have been developed... along with new bonding and strap lining methods, new constructions for high temperature erosion-corrosion service, automatic stud welding. New, non-destructive tests for bonds, linings and welds have been devised.

More is coming soon . . . coming from research into anodic corrosion of lead in sulphuric solutions . . . into lead's age hardening and creep properties . . . into unknowns.

What about lead in your own acid handling equipment . . . considered in the light of this new lead technology? It's worth thinking about, and . . .

Aluminum sulphate.

(From Lee's "Materials of Construction for Chemical Process Industries")



When you think of Lead... think of National Lead

WHAT GOES FOR LEAD AND H_2SO_4 GOES FOR LEAD AND HUNDREDS OF OTHER CORROSIVES

National Lead puts lead in your hands in any grade you may require and in every conceivable form—sheet, pipe, coils, fittings, valves, pumps and vessels. Or you can have National Lead fabricate lead equipment to your specifications.

So put National Lead first in your thinking when you want to combat corrosion. Call on National Lead for technical assistance. Ask for a copy of the new booklet on "Chemical Lead Products."

*Reg. U. S. Pat. Off.

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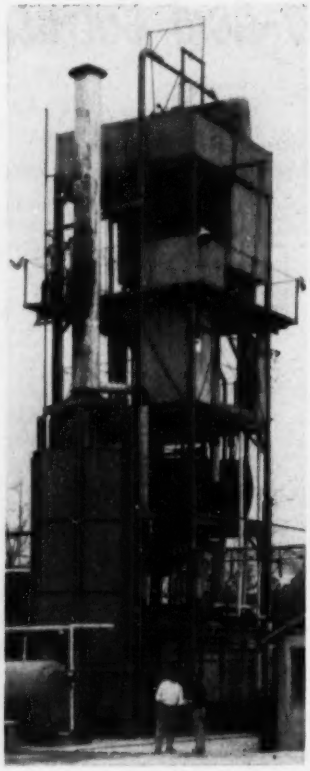
New York 6; Atlanta; Baltimore 3; Buffalo 3; Chicago 80; Cincinnati 3; Cleveland 13; Dallas 2; Philadelphia 25; Pittsburgh 12; St. Louis 1; Boston 6 (National Lead Co. of Mass.); Los Angeles 23 (Morris P. Kirk & Son, Inc.); Toronto, Canada (Canada Metal Company, Ltd.).



Film vaporizing now used by Cactus Chemical. More proof that the . . .

Growth of Tall Oil Relies on Technology

Back around the turn of the century researchers in Sweden began to study the black liquor from their wood-pulping mills. They discovered that skimmings from this mixture—a natural mixture of rosin acids (of the abietic type) and fatty acids (of the oleic and linoleic families)—could be treated to yield a dark brown oil. They called this "tallolja"—Swedish for pine oil.

It just isn't practical to translate this directly into English, since we already have a commodity known as pine oil—a crude turpentine obtained from the destructive distillation of pine wood. Hence, the name came to us as tall oil.

While the early work in Sweden and research elsewhere turned up several uses for the oil, it was looked upon chiefly as a low-grade substitute. And it wasn't until the early '40's that real progress in upgrading it was attained.

During the war, Sweden, critically short of fats, filled nearly all of its inedible fat and oil needs with domestically produced tall oil. At the same time, Germany was putting all the tall oil it could buy, beg or borrow into a wide range of products—from lubricants to paints. And in England they had developed so many outlets for the material that the government had to step in to restrict consumption to three or four of the most essential tall oil products.

In the U. S., tall oil, even the refined variety, has faced competition from abundant supplies of rosin and fatty acids from other sources. To meet this competition the tall oil industry has relied partly on technological progress and partly on the inherent advantages of the oil—low price, steady supply, ample stocks, dependable sources.

Whole tall oil is made up primarily of abietic, oleic and linoleic acids. Its composition, however, will vary widely depending upon the type of wood used in the pulping operation and the region of the country from which it comes. One ton of pulp will yield between 40 and 100 lb. of whole oil, with a national average of about 75 lb.

▶ **Refining It**—It's in taking the whole tall oil and refining it further to remove sales-stifling impurities and to obtain a desired rosin-to-fatty-acid ratio that the trouble comes in.

While there are many methods which could be used to accomplish these ends, perhaps the two which are most used are acid refining and fractional distillation. Acid refining aims primarily at the removal of objectionable impurities, while fractional distillation is employed primarily to separate the rosins from the fatty acids.

Cost is the prime consideration of any tall oil refining plant, and most operators will carry out the refining only so far as tall oil retains its price edge over competitive materials. However, several companies do produce virtually pure fatty acid and rosin acid products.

▶ **Acid Refining**—Probably the simplest method of refining tall oil is the acid refining process. This method does not alter the rosin-to-fatty-acid ratio because it involves no separation, only the removal of impurities.

In this method whole tall oil is first diluted with a solvent, such as mineral spirits, then treated with concentrated sulfuric acid. After mixing and settling to drop out the acid sludge, the reactants are sent to an evaporator which strips off the diluent (this is then recycled) and yields the acid-refined tall oil.

This treatment improves the color and odor associated with the whole oil, thus upgrading it. While acid refining does not alter the composition, a wide variation in the rosin-to-fatty-acid ratio is found when oils from various parts of the country are compared. This makes available oils of a desired composition—within limits—without further "tailoring."

▶ **Fractional Distillation**—If it is desired not only to remove impurities but also to change the composition of the material, tall oil refiners use fractional distillation. This is the method being employed in the newly constructed plants.

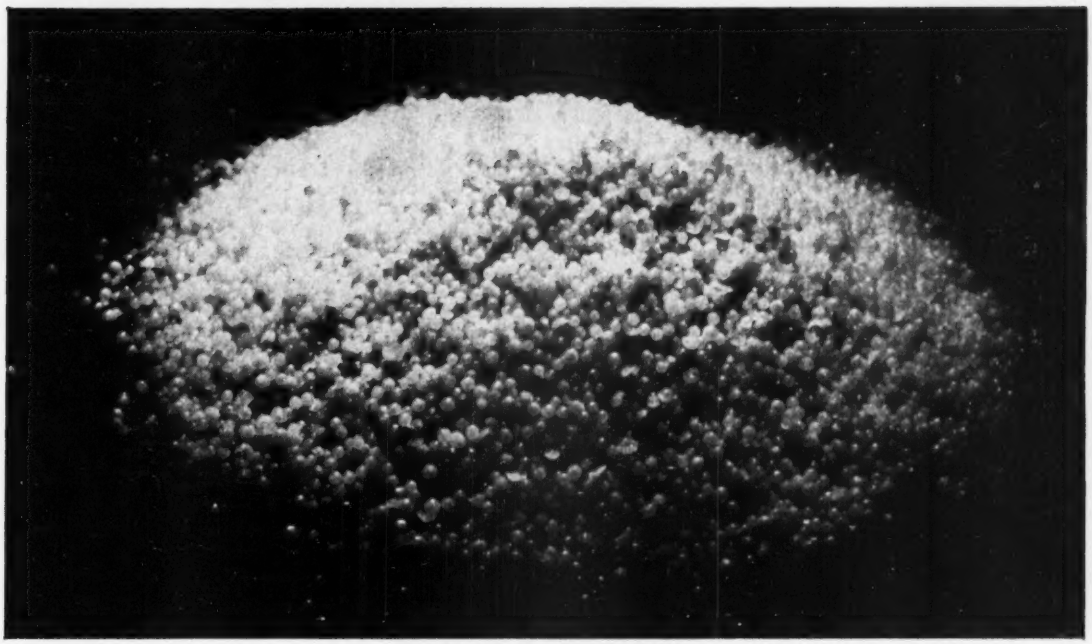
Invariably, this fractionation is carried on under a vacuum to permit the use of lower temperatures.

Although the distillation process has plenty of variations, basically it consists of a preliminary distillation to drop out the high boilers—tall oil pitch—and a further fractionation of the lighter components. This second distillation yields a wide range of products—each of a different rosin-to-fatty-acid ratio.

Each firm in the industry using fractional distillation has worked out its own variations on the basic process theme. For example:

- Newport Industries percolates its oil through fuller's earth to remove impurities.
- Arizona Chemical carries out its distillation in bubble-cap columns in the presence of superheated steam.
- Cactus Chemical Co. film vaporizes and separates whole tall oil at between 400 and 450 deg. F.
- West Virginia Pulp and Paper Co. preheats the whole oil

urea



Urea prills, produced by a newly developed process, practically eliminate caking in packages and storage bins.

by the PECHINEY PROCESS

This commercially proven process, featuring a neutral oil circulating medium for recycling of unconverted Ammonia-Carbon Dioxide, is the lowest cost, minimum corrosion process for the manufacture of high-purity UREA.

Foster Wheeler, exclusive licensor for the Pechiney process in the United States, is now designing and constructing two Pechiney Urea plants with a combined capacity of 410 Tons per day.

Write for Bulletin No. O-54-3

FOSTER WHEELER

165 Broadway, New York 6, N. Y.

in a Dowtherm-heated exchanger, then vaporizes it at about 600 to 625 deg. F. in a Dowtherm-heated tube still. Tall oil pitch drops out and overhead passes through a cyclone separator to remove entrained liquid. Vapor goes on to a condenser where, after condensing, it is further fractionated. Liquid from the cyclone is crystallized at above room temperature (water is the coolant) and centrifuged to recover the rosin fraction—tall oil abietic acid. Liquid from the crystallizer is further distilled to yield other fractions. The system operates at a pressure of about 5 mm. Hg abs.

▶**Propane Extraction**—One other method in commercial use is solvent extraction of the fatty acids with propane.

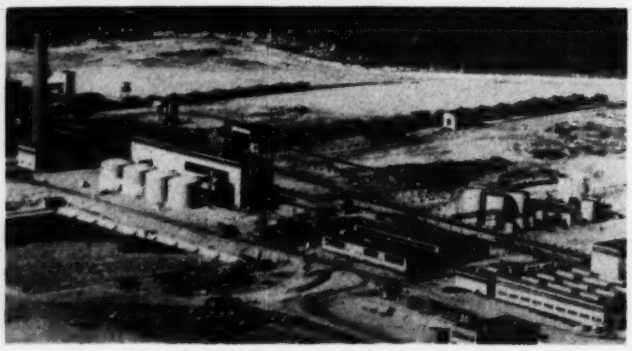
Only one producer, Refinol, Inc., of Cincinnati, Ohio, uses this process at present. However, a good deal of experimental work has been done and at least one engineering firm is offering the process.

▶**Other Methods**—While acid refining and fractionation are the most widely used methods, several others have also shown promise. Solvent extraction using either naphtha or furfural to selectively dissolve the fatty acids is one way that's been tried. Selective esterification—whereby various polyhydric alcohols have been used to yield virtually pure tall oil fatty acid esters—is another.

One of the most intriguing methods is liquid thermal diffusion. This involves the maintenance of a temperature gradient across the liquid—usually achieved by placing the liquid between two parallel walls, one of which is heated, the other cooled.

Diffusion of the abietic acid molecules away from the hot wall and the normal convective flow—upward along the hot wall and downward along the other—combine to concentrate the rosins at the bottom and the fatty acids at the top. (*Chem. Eng.*, Jan. 1952, pp. 222.)

While these methods have looked good in the laboratory, they have not yet been adapted to commercial installations.



Chlorine-caustic plant built for $12 million

Using brine derived from large underground salt deposits, Hooker Electrochemical Co. is now shipping tank cars and barge loads of 50 and 73 percent liquid caustic soda and chlorine from its new Montague, Mich., plant. Built by H. K. Ferguson Co., Cleveland, most of the eight major buildings are steel faced with concrete block and a molded cement-asbestos board, Transite. Hooker expects the plant to become a nucleus for other chemical operations. Du Pont and Union Carbide are already planning major plants on adjoining sides—for neoprene and acetylene.

Brea Chemicals' Ammonia Plant Now Operating

Everybody seems to be building ammonia plants. One of the most recent additions is the $13 million plant just completed by Brea Chemicals, Inc., at Brea, Calif. Brea, a subsidiary of Union Oil Co., expects capacity production of 235 tons/day this month.

Adjacent to the new plant, the company has started construction on a carbon dioxide installation, which, when completed, will make Brea the largest dry ice producer on the West Coast. Also, construction of a $2.5 million nitric acid and ammonium nitrate plant will begin soon.

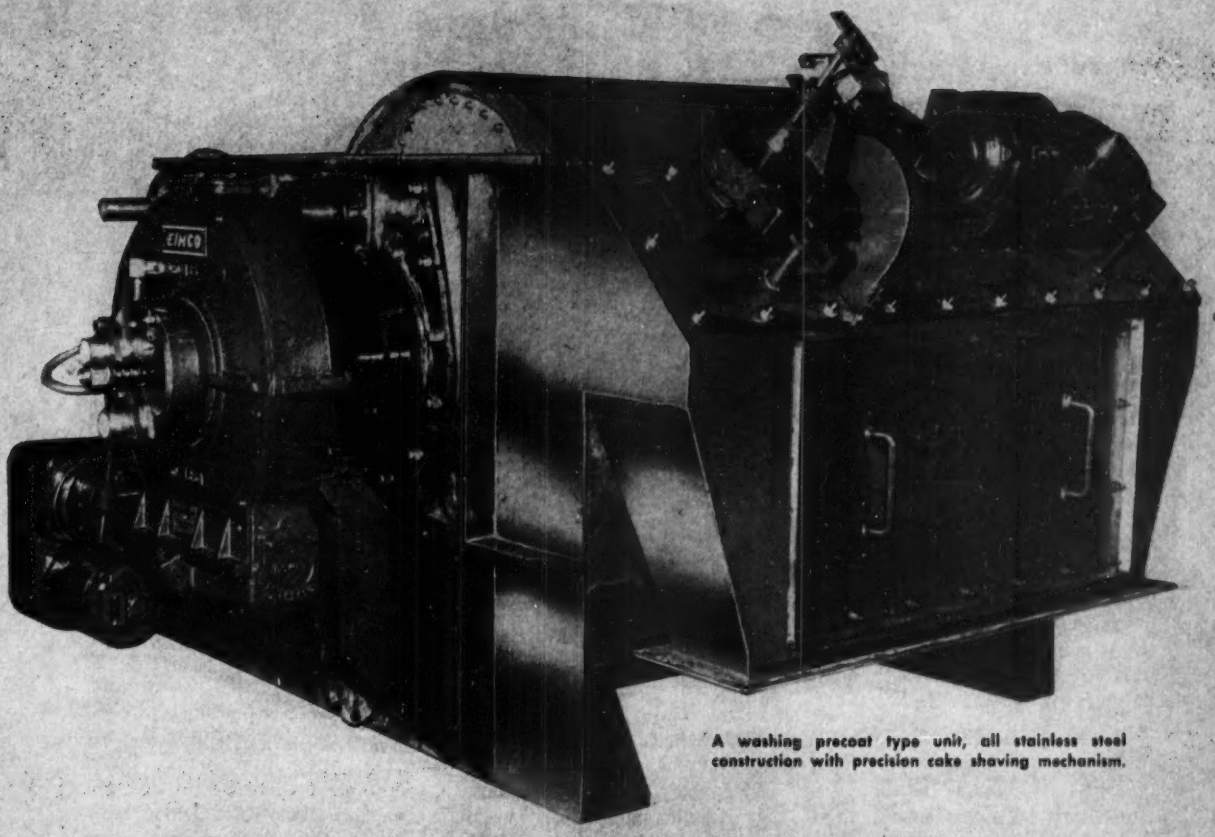
Electrons Create Tougher Polyethylene

Initial experimental offerings of Irrathene, an irradiated polyethylene with increased heat and chemical resistance, are being made by General Electric Co.'s chemical division. Produced in a narrow film, the material's superior properties result from bombardment of normal polyethylene with high-energy cathode rays.

GE uses a modified resonant transformer, or X-ray machine, from which the target has been removed and replaced with a thin metallic window. This enables the electrons to escape into the air and impinge on the material being irradiated. When commercial production is reached, the process will be continuous and high speed. Units capable of accelerating electrons to energies of several million volts will probably be needed.

Irradiation actually changes the molecular structure of polyethylene by cross linking. The product will not melt at any temperature up to the charring point, although it will not withstand indefinite exposure to high heat. And it does not crack when stretched up to 450 percent or when in contact with solvents or other active chemicals.

First use will be in insulating tape and packaging film. Evaluation work is now being conducted on other fabricated forms, such as bottles, housewares and tubing.



A washing precoat type unit, all stainless steel construction with precision cake shaving mechanism.

Washing Precoat Filtration Units

Specialized Eimco filtration units do a better job than standard filtration units where the metallurgy is complicated and the savings are critical.

Here is another typical example of a specialized application where Eimco design and construction played an important part with a consequent greater saving to the customer.

The subject plant was using standard filter press equipment for extraction of a valuable copper sulphate solution from the slurry. A 2% copper sulphate content in the feed was filtered on a unit similar to the one pictured and reduced the CUSO4 to less than 0.5% where as the best obtainable in the presses had been between 0.6—0.7%. Flow rates on the filtrate were increased from .8 gallons/sq. ft./hr. to 4—4.5 gallons per sq. ft. per hr. on a 24 hour basis. Clarity of the filtrate from the Eimco unit was better at all times. Less wash water was used with a resultant lower dilution factor.

More than half a century of experience in serving the process industries, plus unsurpassed research and laboratory facilities make it possible for Eimco to recommend the best type of unit for your process.

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You can't beat an Eimco!

Technical Shows May Return to New York

By April 1956 the $30 million, four-level New York Coliseum will be completed, thus making it possible for the big technical exhibitions to again locate in New York City. Construction is just beginning.

Recently such huge industrial shows as the biennial Exposition of Chemical Industries–the Chem Show–have been forced out of New York due to lack of suitable facilities. But the Coliseum's 275,000 sq. ft. of usable exhibition space–400,000 sq. ft. total floor area–will overcome this limitation. And temporary seating arrangements for as many as 10,000 will allow the structure to be used for conventions, too, although that's not its primary purpose.

Bureau of Mines Shale Research to Continue

The Interior Dept.'s Bureau of Mines' budget request for about $4 million has been cut six percent by the House Appropriation Committee. Although such a cut, if passed by Congress, will mean trimming research programs on synthetic liquid fuel from shale, it won't mean elimination of any projects.

Bureau officials had been afraid that a chance remark made to visiting congressmen at the Laramie, Wyo., research laboratory might have brought an end to work at the Rifle, Colo., development works. The comment: "We have a process that is 10 years ahead of Rifle."

They feared that Congress would not understand that the Laramie experiment was very much in its first stages. It uses only a 2-in. pipe, twenty ft. long; Rifle has a 6-by-10-by-40-ft. retort.

There's no question that Laramie is promising. Using shale fines, workers have been able to make a product that's better in several respects than Rifle's. But whether this advantage can be retained in scaling up is, of course, problematical.

Phillips Makes Plant, Process Plastics News

Two plastics developments by Phillips Petroleum Co. point up the company's increasing emphasis on chemical manufacturing. Of most immediate interest is a new type polyethylene pilot plant to be built on the Houston Ship Channel. Longer range is a new process for making polysulfone resins from oil refinery byproducts.

• The pilot plant is scheduled to turn out Phillips Chemical Co.'s new polyethylene, Marlex 50, by a process that requires much lower investments than conventional polyethylene production methods. Pressure needed is only 500 psi., compared to 15,000 to 30,000 psi. under present processes.

Late last year Phillips indicated that it would build a big ethylene plant at its Ship Channel site. Now, if customer acceptance of the new product warrants, a full-scale commercial polyethylene plant will probably follow.

• Emulsion polymerization is the key to the polysulfone resin process. Sulfur dioxide and an olefinic hydrocarbon, such as 1- or 2-butene, higher aliphatic olefins, cycloolefins or butadiene, are mixed with water, an emulsifier, such as a sodium alkyl sulfate, and a catalyst, such as ammonium nitrate. The mixture is stirred at 100 deg. F. in a glass-lined autoclave for 4-6 hr. Reaction pressure starts at about 75 psig., but quickly drops to about 30 psig. as polymerization progresses.

In the case of 1-butene, conversion is 95-100 percent of theoretical. The yield is a fluid-latex –about 35 percent resin content –which is coagulated with magnesium sulfate solution, filtered, washed and dried. The final product is a finely powdered, fluffy, white thermoplastic resin that can be used alone or blended with nylon, other thermoplastic resins or synthetic rubber.

Phosphates, uranium from new Florida plant

Built at a cost of $15 million, International Minerals and Chemical Corp.'s new Bonnie phosphate plant near Bartow, Fla., (above) is the biggest feed phosphate installation in the world. Principal product is 100,000 tons a year of dicalcium phosphate, sold to feed makers as "20/FOS." In addition, byproduct uranium compounds are being extracted for the Atomic Energy Commission as an intermediate step in the production of multiple superphosphates.

For more WHAT'S HAPPENING . . . Page 414

"NICHOLSON TRAPS PROVE THEMSELVES"

..in plant of one of Big 6 chemical firms

The importance of improving heat transfer efficiency in today's great processing plants increases as the proportion of critical applications grows and steam consumption mounts. The letter at the right is from one of the great chemical companies which have adopted Nicholson traps. Another of them recently reported that Nicholson traps were installed at one of their plants as part of a campaign to promote economical steam use. It resulted in a yearly saving of $500,000. See why an increasing number of leading plants are standardizing on Nicholsons.

...HEMICAL COMPANY

...ATTANOOGA, TN.

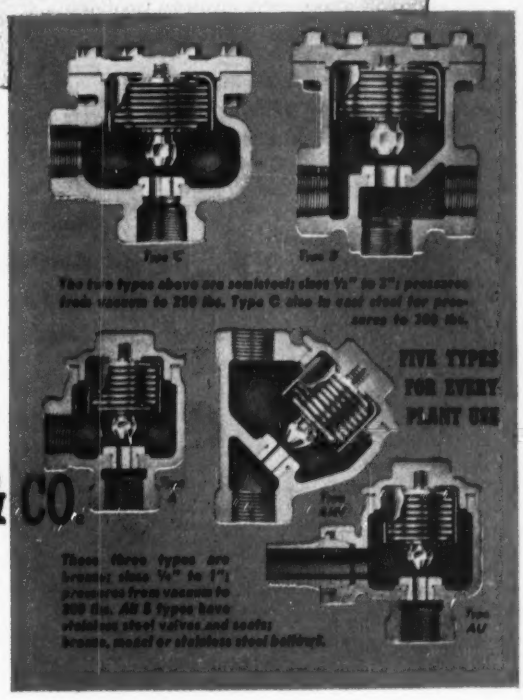
W. H. Nicholson & Co.
Wilkes-Barre, Pa.

Gentlemen:

Your representative, Mr. _____, said he believed you would appreciate it if we would send along to you the following information on Nicholson steam traps used in our plant.

We use above traps for processing and heating. We have previously used____ ____, _____ and _____ traps. Some of these are still in use. However, Nicholson traps have proved themselves in our plant. We do not have a record of our saving in heat-up time and increased production.

Yours very truly,
Signature Deleted



Send for TRAP CATALOG 953

This 32-page standard reference is complete with installation diagrams as well as charts and formulae for determining proper size of trap.

W. H. NICHOLSON & CO.

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for your information...

brief summaries of helpful product news

New Compound Developed by Monsanto Reduces Loss of Carotene in Alfalfa Meal

A promising new chemical has recently been developed for reducing the loss of carotene in dehydrated alfalfa meal during storage.

Carotene is an important constituent of the dehydrated alfalfa meal used in animal feeds because it is converted by the animal system to vitamin A, an essential growth and reproductive factor.

Carotene Loss Cut

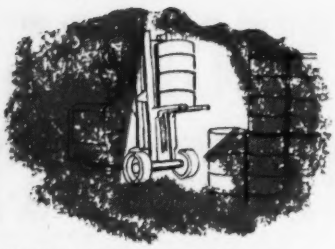
The new chemical which reduces carotene loss is called Santoquin* and—at this time—is for use only on alfalfa going into poultry feeds.

Santoquin acts by slowing down the action of the oxygen on carotene. Laboratory and field tests have shown that the addition of only 0.3 of a pound of this compound to each ton of alfalfa meal may more than *double* the retention of carotene after six to eight months' storage.

Several advantages can be gained through the use of Santoquin.

First, a higher percentage of carotene can be preserved in alfalfa meal during warehousing, with a consequent upgrading in market value. Second, a less expensive system of handling the rotation of dehydrated meal in storage can be used. Third, blending programs become simpler and dusting is reduced, thanks to the oil which is used as a carrier for Santoquin. This means better working conditions inside the mill and reduced meal losses from processing and handling.

Send coupon for complete information.



Methyl Toluene Sulfonate Available from Monsanto

Monsanto methyl toluene sulfonate is a mild methylating agent used primarily in the manufacture of pharmaceuticals and dyes. Its use can save the manufacturer time, since he receives a methylating agent without performing the step of esterification.

Shipped in 55-gallon drums, methyl toluene sulfonate has a limited toxicity and is relatively easy to handle. It does not require pressure reaction equipment because of its low volatility. More important, the M.T.S. end product of methylation reaction is an alkali metal salt of toluene sulfonic acid which is less corrosive than the strong acid salts of certain other agents.

For more information, send in the coupon today.

Research Chemist's Corner

SUCCINONITRILE

Formula: $CH_2—C\equiv N$ / $CH_2—C\equiv N$ — **Mol. Wt.** 80

Approximate Properties:

Appearance:	Waxy solid
Assay:	99+%
Odor:	None
Crystallization Point:	54° C. min.
Specific Gravity:	0.98 at 60° C.
Solubility in common solvents:	Slightly soluble in water, benzene and ethanol. Soluble in acetone, chloroform and dioxane.
Stability:	Succinonitrile has been held at 200° C. for 72 hours without appreciable decomposition.
Brief statement of chemical properties:	Will undergo the typical reactions of the nitrile group. Can be readily reduced in high yields to pyrrolidine. Liquid phase chlorination yields an interesting series of unsaturated chlorinated nitriles.

Experimental quantities available to qualified chemists.

Nontoxic Plasticizer Has Many Applications

If you are searching for an effective plasticizer which can be used in vinyl film and sheeting, in packaging materials and adhesives, in plastisols and organosols, you will want to investigate Santicizer* 141.

This compound has an extremely valuable feature: it is nontoxic. After being subjected to exhaustive toxicity studies covering more than three years, Santicizer 141 has been fully approved by the Bureau of Animal Industry as a nontoxic plasticizer for use in containers, wrapping films, packaging materials and other plastic products intended for contact with food items.

Because it does not irritate human tissues, Santicizer 141 has also been effective in a number of specialty items. These include hospital sheeting and tubing, plastic baby clothing, shoes, dentures and anatomical restorations.

Santicizer 141 improves the processing characteristics of most formulations because of excellent resin solvation. It also imparts several other important characteristics to the finished plastic: flame resistance, low-temperature flexibility, nonvolatility, and good resistance to abrasion, oil, grease, and weathering.

Find out more on how this versatile product can help solve *your* processing problems. The coupon brings you complete information and technical bulletin.

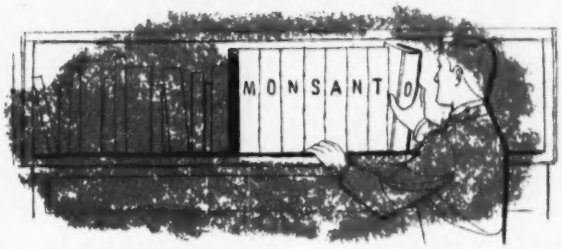
New Coumarin Use

New application for coumarin is its use as a mask in animal glues for gummed tape. Processors like to use coumarin because of its high "staying power," even after heat has been applied during processing.

Quick Facts

More than 35,000 different items are manufactured from rubber. Monsanto supplies accelerators, antioxidants and special materials to the rubber industry in large quantity.

from the MONSANTO BOOKSHELF...



Chloro-IPC . . . this new bulletin completely describes Chloro-IPC and its use for weed control. Included are sections describing the herbicidal action, soil life and application of Chloro-IPC, and a list of weeds which it controls. Helpful information is also given on different types of Chloro-IPC formulations which are possible. Send the coupon today for your copy.

Fumaric Acid . . . A new bulletin is packed with helpful information concerning Fumaric Acid applications in coatings and polyester resins. Fumaric acid is a polyfunctional acid capable of a wide diversity of chemical reactions because of its two carboxyl groups and an active double bond. These are particularly suited for polymer formation. The bulletin, which is primarily for the synthetic resin trade, covers such subjects as chemical reactions, fumaric acid in drying oils, in tall oil varnishes, in steam-set inks, and in polyester resins. It also gives details on experimental research with fumaric acid in alkyd resins. The coupon will bring your copy by return mail.

DOA . . . a new technical bulletin on di(2-ethylhexyl) adipate is yours upon request. This bulletin will bring you basic technical information on this widely used plasticizer which is used by the vinyl industry for imparting low-temperature flexibility. The bulletin covers physical properties and has several tables showing properties of polyvinyl chloride plasticized with DOA. Other tables show viscosity build-up in plastisols and typical hose formulations. Clip the coupon and mail for your copy.

DNODP . . . DI (n-OCTYL, n-DECYL) PHTHALATE, this plasticizer, which is a superior product for vinyl film, vinyl sheeting and garden hose, is covered in a new technical bulletin just published by Monsanto. The bulletin gives details on physical and chemical properties together with tables showing the effect of plasticizers on physical properties of polyvinyl chloride plastics. Other information includes sections on sheeting formulations, DNODP in vinyl dispersions, and material on electrical properties. Send coupon now for your copy.

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- ☐ Santicizer 141 Bulletin
- ☐ Succinonitrile Data Sheet
- ☐ Succinonitrile Sample
- ☐ Chloro-IPC Bulletin O-114
- ☐ Fumaric Acid Bulletin O-115
- ☐ DOA Bulletin O-106
- ☐ D N ODP Bulletin O-109

Name .....
Company ..... Title .....
Street .....
City ..... Zone ..... State .....

Tall Oils: Plentiful and Promising

Twice-blessed, tall oil and its components have an abundant source and a market waiting. Cheaper refining methods will build a better bridge between the two.

Tall oils are mixtures of fatty acids and rosin acids in combination with small amounts of unsaponifiable substances. Crude or whole tall oil is produced by splitting, with sulfuric acid, the skimmings—sodium salts of the rosin and fatty acids—produced when pine wood is chemically pulped by the Kraft sulfate process.

Originating as they do in widely separated areas of the country, these crude tall oils vary in composition:

- Fatty acids—30-35 percent (broken down, these are oleic, 45-50 percent; linoleic, 45-50 percent; palmitic, 5-7 percent.)
- Rosin acids—35-60 percent (abietic, 30-40 percent; neoabietic, 10-20 percent).
- Unsaponifiables—5-10 percent (beta-sitosterol, 25-30 percent.)

This combination is highly desirable for such uses as soaps, emulsifiers, paint driers, and drying oils of all types. It is not too unsaturated for many soap products, yet not too saturated for many paints and varnishes.

And, in order to suit a particular demand, the whole tall oil can be processed further to improve its color, odor and to change its composition. The ratio of fatty to rosin acids can be varied widely, usually in favor of higher fatty acid concentrations, to a point where the tall oil, as such, ceases to exist, giving way to substantially pure fatty and rosin fractions.

Some refiners use acid purification processes—whole tall oil treated with concentrated sulfuric and impurities removed as an acid sludge. This gives a product practically unchanged in fatty and rosin acid composition in yields of 85-90 percent. Other use distillation methods to give products of varying composition in yields of approximately 75 percent.

▶ Facts and Figures—Tall oils have experienced rapid growth in just a few years but their future promises even more room for expansion. Let's look at some figures:

Domestic consumption — up nearly one-third in 1953 over 1948: 283 million pounds vs. 214 million pounds. Add to this exports now running about 40 million pounds a year.

Total inedible fats and oils market—tall oils ranked fourth in 1953, surpassed only by tallow, linseed oil and coconut oil. They contributed more than 7 percent of the fats and oils used for non food end products (a 3.5 billion pound market last year).

Drying oils market—Tall oils ranked third in 1953 (only linseed and soybean oils were ahead), contributing 7 percent of the 1 billion pounds of fats and oils consumed for this purpose. They also placed fourth—behind linseed, soybean and tung oils—in paint and varnish jobs. About 31 percent of all tall oil consumption goes to the drying oil field: 5, 5, 11 and 10 percent going to linoleum, resins, paint and varnish, and miscellaneous, respectively.

Whole oil to refined oil ratios—Production of refined and distilled grades ran about 27 percent of all tall oil produced; their sales constituted about 30 percent of all tall oil sold.

Availability—Source of all tall oils—the Kraft paper industry—has really been tearing along in recent years: 5 million tons of pulp in 1948, 8 million in 1953. Translated in terms of tall oil potential these figures mean that tall oil available from pulp in 1948 was 350 million pounds, in 1953, 560 million lb. (One ton of pulp yields about 70 lb. of crude oil.) Thus tall oil production will not be squeezed at the source for some time.

Tall Oil
contains . . .

Oleic acid
Linoleic acid
Palmitic acid
. . . for paints

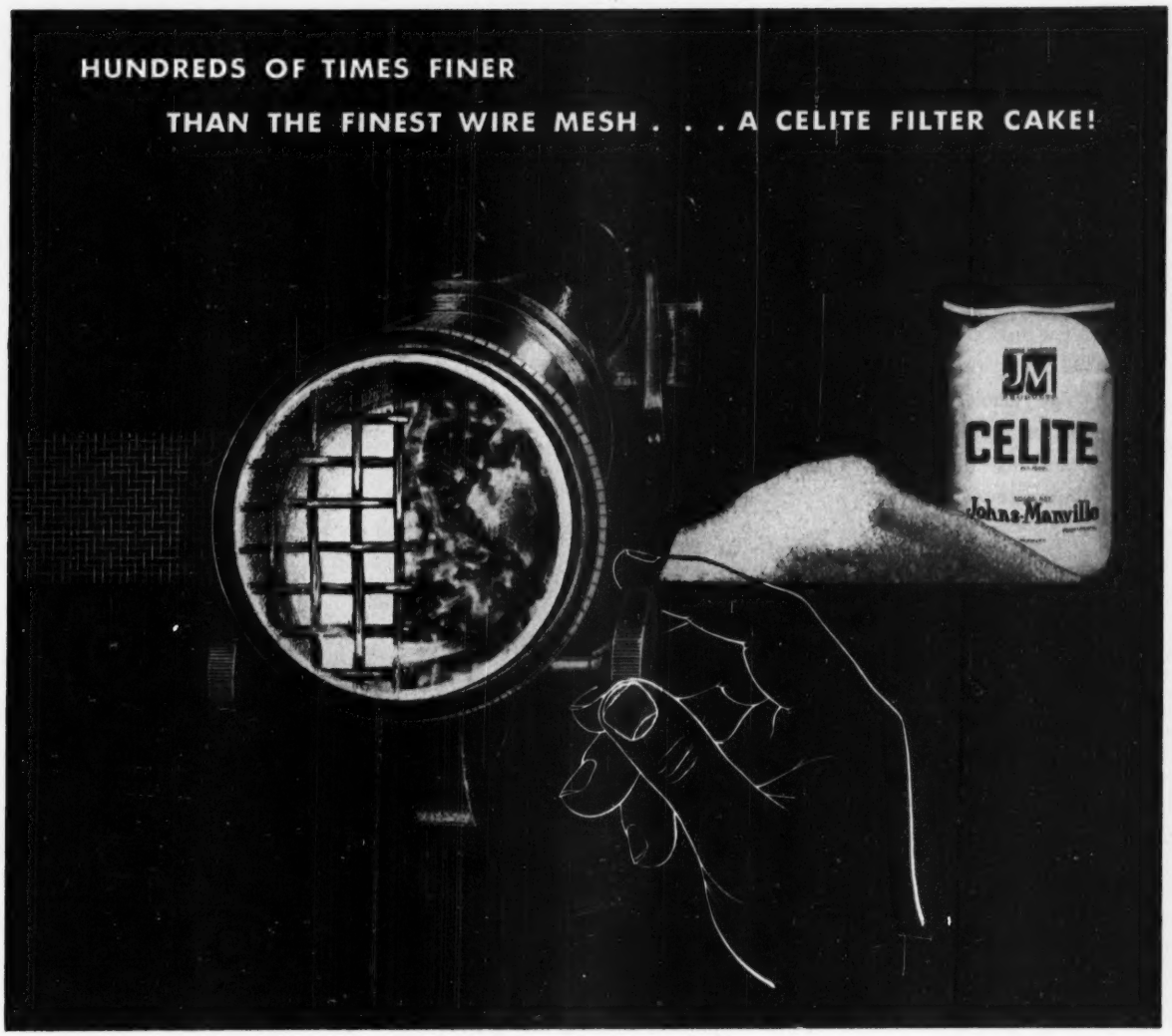
Abietic acids
Pyrobietic acids
Pimaric acids
. . . for soaps

Beta Sitosterol
. . . for cortisone

Price—Two words, stable and low, describe tall oil prices. In 1949 refined tall oil was 5.4 c. per lb.; in 1953, 5.0 c. per lb., with only small fluctuations in between. Cost of crude tall oil as of March, 1954, was $40 a ton. Some grades cost 1-2 c. per lb. more, depending upon the degree of refinement. Other fats and oil prices wavered much more sharply in the same period.

▶ Reasons for Demand—Tall oils are finding favor, and here are the reasons why: they are low in price, available in a free market, have a large and steady domestic source of supply, and are chemically versatile. To date there are no government regulations on their marketing or price; tall oils are not associated with food products.

Low stable cost—Whole tall oil is the lowest priced organic acid in the world. Unlike most industrial oils, tall oil is not related to edibles; its prices are not influenced by



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Celite powders may be used with any type of conventional filter. Only 2 simple steps are required. First, a "pre-coat" of Celite is deposited on the filter medium. Second, small amounts of Celite are added to the solution, to form a continuously fresh filter surface. To meet different filtration requirements, Celite is available in nine standard grades of microscopically controlled particle size. Utmost uniformity is assured by exclusive processing techniques.

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If you want to improve your present filtration system or find an economical way to utilize filtration in your processing, investigate the Celite method now. One of the Johns-Manville Celite Filtration Engineers will gladly discuss your problem. These men are backed by complete technical services and the Johns-Manville Research Center, largest laboratory of its kind in the world. For further information write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

*Celite is Johns-Manville's registered Trade Mark for its diatomaceous silica products.

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Page Number is also Reader Service code number

Tail oils are plentiful and promising 142A
Impact-resistant resin 146A
Fluorocarbon rubber 146B
Food antioxidant 148A
Algae grow in plastic tubes 148B
Oil sludge prevention 148C
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Starch derivatives for paper industry 150B
Protective coatings 150C
High viscosity silicones 150D
Chemical bonds for laminated plastics 150E
Adhesive for Teflon 152A
Polyamide-epoxy resins 152B
Isopropylaminoethanols 152C
High molecular weight by polyisobutylenes . . . 152D
Refrigerant for very low temperatures 152E
Methoxy- and butoxyethyl acrylates 152F
Solvent-resistant grease 152G
Adhesive primer for plastic tape 152H

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food shortages and price support programs. Pulp mills, anxious to develop such an enormous potential byproduct, value their skimmings at a comparatively low figure. With this low cost raw material as a basis, tall oils may be refined to many grades priced quite low compared to other fats and oils and to rosin, all of which are quite costly to collect and bring together for processing.

Good supply—There are no crop failures to vary the availability of tall oils.

Tall oils are products of the paper industry, which is very stable and growing. Further expansion in Kraft pulping is expected to add 20 percent to its present capacity, and to tall oil capacity, in the next three or four years. Tall oil supplies may be further augmented by greater efficiency in their recovery from pulp waste liquor.

Since the paper industry uses much costly equipment that must be operated around the clock to be profitable, manufacturers of tall oils can work just as steadily.

▶ **Fatty Acids**—The fatty acids in tall oils react chemically in typical fashion. They form water-soluble soaps with alkalis, ammonia and amines and water insolubles, oil soluble soaps with heavy metal salts. Esters are produced by heating with monohydric or polyhydric alcohols, while amides are formed by heating the amine salts. Reduction of the alkyl esters with sodium produces a mixture of unsaturated alcohols, while high pressure hydrogenations yields saturated alcohols. Reaction with ethylene oxide yields condensation products valuable as detergents.

The double bonds in linoleic acid are responsible for such properties as air drying of tall oil fatty acid esters, reactions with maleic anhydride and styrene, polymerization and bodying by heat or air blowing. The ethylenic linkages of both oleic and linoleic acid allow sulfonation with sulfuric acid. Reaction with sulfur gives polymeric products cross linked with sulfur atoms. Unsaturated acids are converted to saturated acids by catalytic hydrogenation; limited amounts of hydrogen will yield a product consisting mainly of oleic acid.

The linoleic acid content brings tall oil fatty acids into the range of semi-drying fatty acids used in medium and long chain oil alkyds. The nearly complete absence of linolenic acid accounts for the non-yellowing properties so valuable in white baking enamels.

Esters with polyfunctional alcohols, such as pentaerythritol and polypentaerythritol, have fair drying and good film properties, which can be improved by maleation, styrenation and condensation with phenolic resins.

▶ **Rosin Acids**—Although many of the reactions of the rosin acids are similar to those already claimed for the fatty acids, a few others should be mentioned: reaction of the rosin acids with lime or zinc oxide produces higher melting oil—and solvent-soluble salts used in varnishes and printing inks. Salts of lead, manganese and cobalt are useful as driers. A major use for the sodium salt is in sizing paper.

The double bonds in the rosin acids take part in a number of reactions: hydrogenation, polymerization and condensation with maleic anhydride. The latter reaction yields a product which can be further treated with a polyhydric alcohol to produce high melting resins compatible with nitrocellulose and useful in furniture lacquers and sanding sealers. The sodium salt of the original condensation product also is a superior paper sizer.

▶ **Unsaponifiables**—Of chief interest in this small fraction is beta-sitosterol which has been used to synthesize sex hormones and other biological compounds. Lately there has been considerable interest in the use of this compound as a possible starting material for the synthesis of cortical steroids, such as cortisone.

▶ **Special Advantages**—Tall oils, containing both rosins and fatty acids, behave similarly to other sources of these products. The obvious question is: why use them at all? Low cost is, of course, a big reason. But

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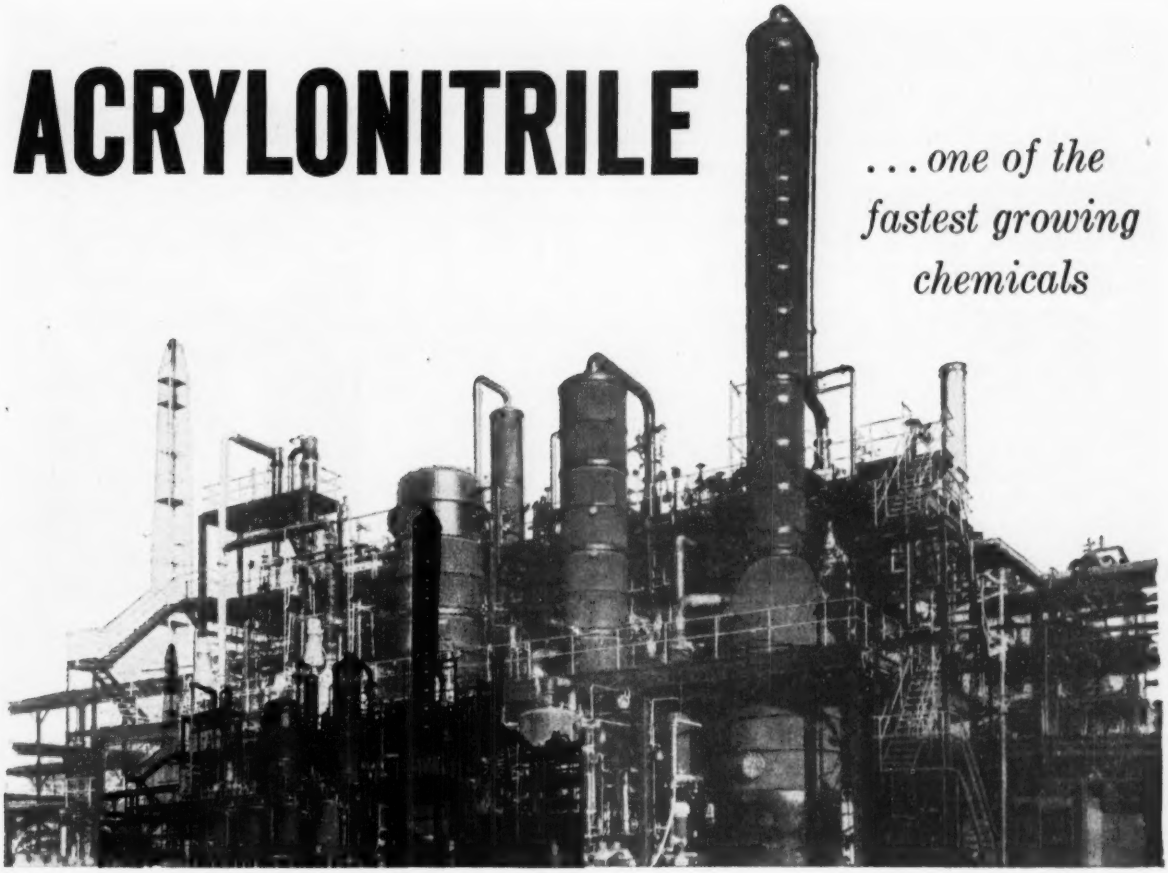
. . . one of the fastest growing chemicals



NOW AVAILABLE IN TONNAGE QUANTITIES FROM CARBIDE

CARBIDE's production facilities for this reactive monomer will help meet the demand of the plastics, rubber, synthetic fibers, and related industries.

Polymers and copolymers of acrylonitrile have these desirable properties:

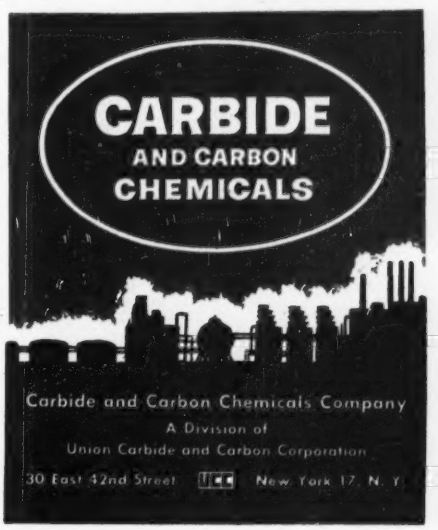
- increased resistance to sunlight and exposure
- high heat resistance
- increased flex and impact strength
- resistance to moisture, greases, solvents, and other chemicals

Acrylonitrile (*vinyl* cyanide) can be used as a source for introducing the cyanoethyl group in other organic compounds. These cyanoethylation reactions are important in the preparation of antioxidants, chemotherapeutics, dyes, emulsifying agents, solvents, and epoxide resin catalysts.

OTHER CARBIDE *VINYL* MONOMERS

Acrylonitrile is but one of a large number of *vinyl* monomers available from CARBIDE in commercial quantities. Some of these are vinyl acetate, butadiene, styrene, ethyl acrylate, crotonic acid and a large number of related compounds.

CARBIDE will be glad to assist you in evaluating acrylonitrile or one of the other reactive monomers for your particular production problem. For further information—call or write the CARBIDE office nearest you.



there are other advantages which several industries are exploiting.

Soaps–Since saponification can be effected merely by mixing tall oils with various bases, very simple equipment is required. This is a distinct advantage over natural fats and oil which require boiling for saponification and salting out to separate the soap from the glycerol and excess alkali. This should appeal to small soapmakers and those in the chemical specialties field.

Sodium soaps of tall oil are more water soluble than those of the more saturated fatty acids, like tallow and coconut oil, particularly at low temperatures. In some cases you can substitute sodium soaps for those of potassium with a double-barreled saving: low cost fatty acid and low cost alkali.

And tall oil soaps are less viscous as a rule. They can be blended with more saturated fatty acids and used as dispersants in oil emulsions to give better stability and surface activity. When expensive alkalis such as triethanolamine or morpholine are used, the low acid numbers of tall oils offer savings of 10 percent or more.

Emulsions–A number of soluble oil manufacturers favor tall oil soaps as emulsifiers because of their high oil solubility. Insecticidal emulsions of DDT, chlordane and toxaphene are being prepared with tall oil emulsifiers. Also, considerable amounts of tall oil go into making cutting oils–both clear and emulsion types–and into asphalt emulsions.

Paint driers–These agents are generally metal-organo compounds; the metal catalyzes drying time, the organic portion solubilizes the metal in the coating. Until recently only napthenates and ethyl hexoates have been suitable. But tallates –salts of tall oil acids and drying metals–are replacing them because of their lower cost and greater solubility.

And these properties can be improved by aldehyde pretreatment. A lower acid number results, causing greater quantities of the metal to react with the same amount of oil.

Drying oils–Limed tall oils act as gloss oils in interior paints. However, their substitution for about 25 percent of linseed oil is said to be practical in many outdoor paints with little sacrifice in their useful life.

Tall oil esters are superior to limed oils in water and alkali resistance and film toughness. The rosin esters–hard solids–are added to drying oils to improve dried film hardness. Tall oil as a source of rosin acids is much more convenient to handle than the solid rosins.

Modified alkyds–Tall oils are used as modifiers in the production of alkyd resins to control cross linkage and at the same time impart desirable qualities of solubility, gloss and flexibility. Superior in these respects to straight oil modified alkyds, the tall oil resins cost substantially less: high alkyd viscosities are achieved with less phthalic anhydride–a pentacrythritol tall oil alkyd of 18-20 percent phthalic has the same viscosity as a 28 percent phthalic, oil-modified PTE alkyd with no decrease in stability.

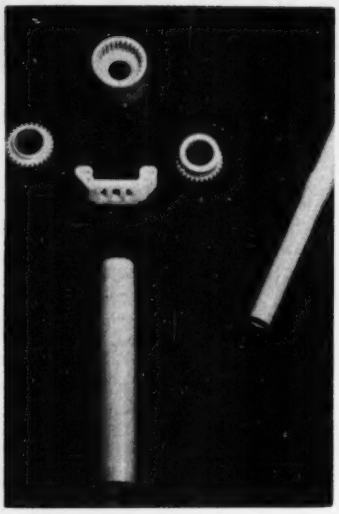
▶ **More Recent Developments**–Tall oil reacts with epoxy resins, too, to give superior quick-drying varnishes without the addition of more expensive, fast-drying oils. Tall oil cyclopentadiene condensation products are reported to be soluble in drying oils as well as in usual paint solvents, thus affording glycerine economy.

And tall oils have been styrenated and then esterified with a number of polyalcohols. Varnishes made in this manner from a 62 percent fatty acid tall oil and tripentaerythritol give fast drying films of excellent flexibility, good brushability and water resistance.

142A

For More Information . . .

about any item in this department, circle its code number on the Reader Service Postcard inside the back cover.



Cycolac Resin

High-impact thermoplastic resin performs well over wide range of temperatures.

A new resin, Cycolac, selling initially for 65 c./lb., is hard, light and tough, easily worked and can be sprayed in colors on elastic rubber surfaces.

Piping made from the thermoplastic, styrene-type resin withstands 200 psi. pressures, is eight times lighter than iron and steel and resists hydrochloric and dilute sulfuric acids as well as alkalis. Other suggested uses: molded fittings, automotive equipment, machine housings, ventilating systems and chemical process equipment.–**Marbon Corp., Gary, Indiana.**

146A

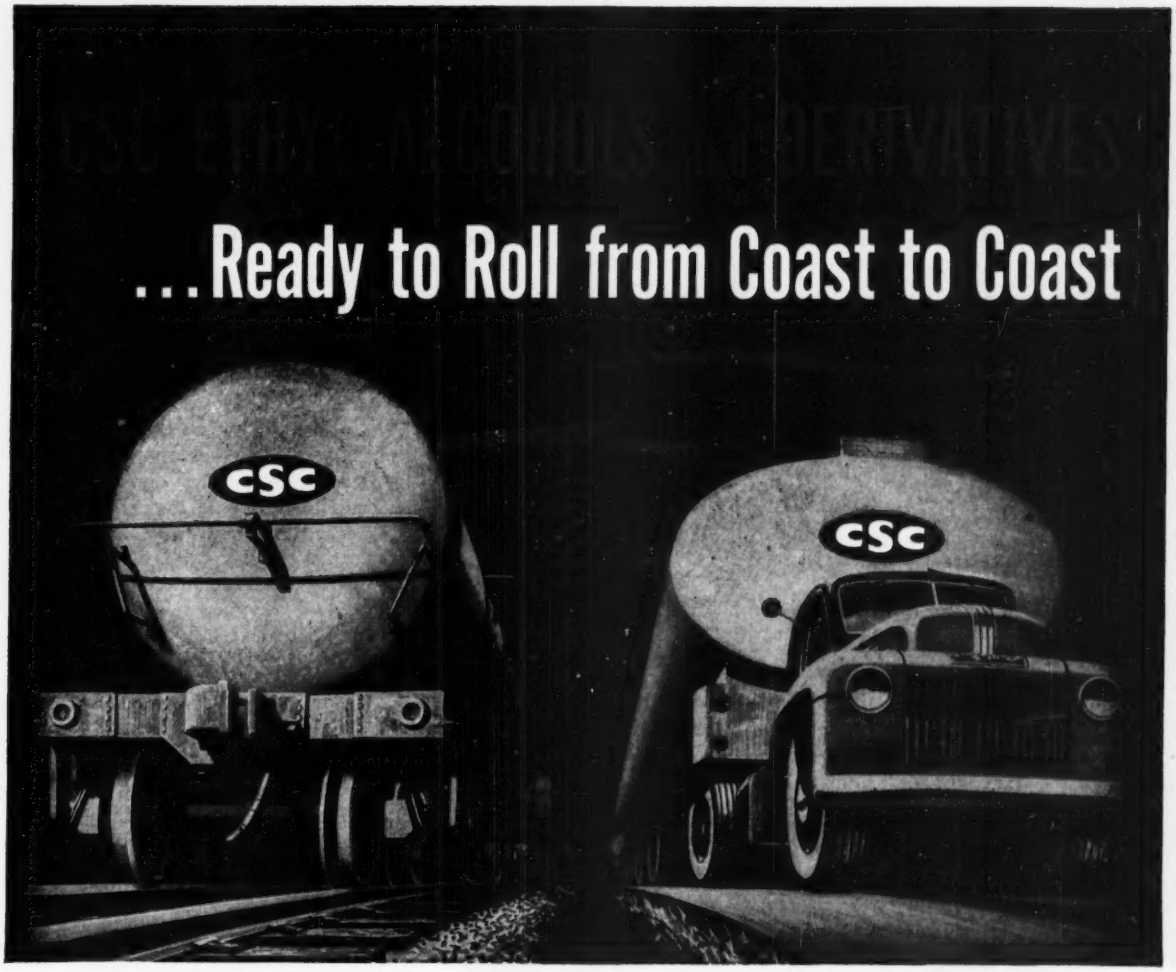
Kel-F Elastomer

Exceptional chemical and heat resistance are the big features.

Kel-F (trifluorochloroethylene) in elastomer form is moving into the pilot plant stage. Potential uses for this new synthetic rubber include fuel hose, tank linings, gaskets, seals, diaphragms and valve seats, plus coatings for clothes used in corrosive material handling and for paper, wood and metal.

Kel-F elastomer withstands fuming nitric and sulfuric acid, hydrocarbon fuels and lubricants, oxygen,

...Ready to Roll from Coast to Coast



Usage for industrial alcohols has reached an unparalleled level during the past decade . . . creating a demand that Commercial Solvents Corporation, a pioneer in alcohol research and production, has answered by producing more ethyl alcohols and derivatives for the chemical industry.

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CSC ethyl alcohols are available in all formulas and grades to meet the most exacting requirements of the pharmaceutical and industrial trades.

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Tributyl Phosphate	Pentaerythritol
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ozone and sunlight. No other natural or synthetic rubber, it is claimed, possesses such broad corrosion resistance. Non-flammability, toughness and heat resistance (–15 to 400 deg. F.) round out the properties.

The pilot plant, scheduled for completion late this year, will make several thousand pounds of Kel-F elastomer monthly, all tickcted for the military. Samples will be available, though, for industrial evaluation.–**M. W. Kellogg Co., Jersey City, N. J.** **146B**

•

Antioxidant's New Role

FDA certifies preservative is safe for human consumption.

The food, drug and allied industries may now use 2,6-ditertiary butyl-p-cresol, a well-known preservative, in their processing. Three years of toxicity studies have satisfied the Food and Drug Administration that this antioxidant is suitable for use as a food additive.

Particularly effective against rancidity in fat-containing foods, the chemical will find use in shortenings and other cooking agents as well as in finished foods. Other new uses: protecting certain vitamins from oxidation; stabilizing rubber and plastic compositions used in food handling equipment.

Tests show that the preservative will cost processors as little as one cent per hundred lb. of food treated; most other comparable food-grade-antioxidants used widely today cost more.

2,6-ditertiary butyl-p-cresol is supplied by Koppers (Koppers DBPC) and Shell Chemical (Ionol-CP).–**Koppers Co., Inc., Pittsburgh 19, Pa. and Shell Chemical Corp., New York 20, N. Y.** **148A**

Food of future grows in giant plastic tubes

Continuous pilot plant production of Chlorella algae for food is now feasible–and polyethylene is helping Arthur D. Little, Inc., make it so. Set on the roof of a Cambridge, Mass., building (above), two 160-ft. tubes of the plastic enclose the aqueous culture of tiny green plants. Air with 5 percent CO_2, sunlight and small amounts of inorganic salts are all that's needed for cultivating this potential commercial source of concentrated protein. Polyethylene tubing combines light transmission with strength, freedom from toxicity and chemical and physical stability under exposed conditions.–**Bakelite Co., New York 16, N. Y.** **148B**

Oil Sludge Prevention

Methacrylate polymers sequester sludge, help keep fuel oils and lubricants clean.

Two new oil-soluble chemical additives can act as points of attraction for sludge-like materials and prevent them from settling out.

Developed by Du Pont to protect oil burner fuel lines from clogging and to guard against crankcase sludge in cars, the products are: Copolymer S–four parts lauryl methacrylate and one part diethylamino ethyl methacrylate–for fuel oils; Copolymer D–another methacrylate–for lube oils.

• Copolymer S, in concentrations between 0.0015 and 0.01 percent, suppressed formation of insoluble residue in fuel oils for the first 4-6 months of storage. And although the amount of residue after 18 months had equaled that accumulated in untreated oil, its character was different–the control fuel clogged burner screens while Copolymer S-treated oil was essentially non-clogging.

• Copolymer D controls varnish and sludge formation in lubricants used in high-temperature work –diesel engines and spark-ignited engines under heavy load. It is even more effective at the low temperatures encountered in normal, stop-and-go auto and truck operation in urban areas.–**E. I. du Pont de Nemours & Co., Wilmington 98, Del.** **148C**

Paint Chemicals

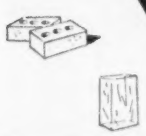
Water resistant emulsion and freeze-thaw stable latex.

Two new products are being offered to the protective coating industry: Polyco 556, a butadiene-styrene latex, and Polyco 522, a polyvinyl acetate emulsion.

As a vehicle for primers and topcoats, Polyco 522 resists freeze-thaw cycles and can develop films of high water resistance (2,100 by Gardner Scrub Test). Paints made with the emulsion adhere readily to plaster, concrete and stucco, exhibiting stability in color fastness tests (non-

NH_4Cl

These properties of SOLVAY AMMONIUM CHLORIDE may be useful in Your operations



Some Typical USES and MARKETS for SOLVAY Ammonium Chloride

- **Dry Cell Batteries**
- **Textiles** dyeing operations
- **Flux** used in galvanizing and soldering
- **Leather** compounding of "Tanners bate"
- **Yeast Food**
- **Urea-Formaldehyde**
- **Resins and Adhesives** provides acid salt to accelerate polymerisation.
- **Alkaline Cleansers** source of dry Ammonia
- **Bricks** offsets effects of pyrites in clay
- **Ice Manufacturing** produces clear, non-brittle ice
- **Snow Treatment** slows melting on ski slopes
- **Fireproofing Agent** for temporary treatment of paper and textiles
- **Blasting Powder**
- **Water Purification**
- **Foundries** casting sealer
- **Soot Remover**
- **Veterinarian Medicines**

CHECK THESE PHYSICAL and CHEMICAL PROPERTIES of SOLVAY AMMONIUM CHLORIDE

Molecular Weight: 53.50

Solubility in water: 20% at −13° C, 25% at 10°C, 30% at 33°C, 40% at 83°C. Strongly endothermic (lowers solution temperature upon dissolving). Aqueous solubility suppressed by sodium chloride. Slightly soluble in methyl and ethyl alcohol and acetone. Fair solubility in glycerine.

Melting Point: Sublimes.

pH of Solutions: 25°C: 1% 5.5, 3% 5.1, 10% 5.0 (technical grade).

Appearance: White crystals, practically 100% will pass through a No. 20 screen. Tends to cake upon storage.

Reactions: Decomposed in solution by strong alkalies to liberate ammonia. Reacts with nitrites to form nitrogen. Reported to reduce oxides of cobalt and nickel at high temperatures. Hydroxides of nickel, zinc, cadmium and manganese reported to be more soluble in water in presence of ammonium chloride. Acid characteristics cause acceleration of set of urea-formaldehyde resins.

Quality: Principal impurity is sodium chloride. Very low in metallic impurities. Technical grade better than 99% NH_4Cl.

This stable, low-cost, high purity salt has such a wide variety of properties that its uses range from the manufacture of dry cell batteries . . . to its use as a flux in galvanizing and soldering . . . to the application of its endothermic action in retarding the melting of snow.

SOLVAY Ammonium Chloride is *highly soluble* at even relatively *low temperatures.* It is an active electrolyte in water—it has an acid reaction—it has an extremely low metallic content—and it also appears to have the ability to act as a catalyst in certain organic reactions.

TEST SAMPLES and further details are available at no cost or obligation. Write us giving information on your operation so that we can best evaluate how SOLVAY Ammonium Chloride can fit into your particular situation. All information will be kept in strictest confidence.

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Gentlemen: I am interested in the possible use of SOLVAY Ammonium Chloride in my operations. Please send me, without cost or obligation, samples and further information.

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yellowing after 30 min. at 350 deg. F.). Viscosity, normally 1,500 centipoises, only goes up to 4,000 cp. after accelerated aging in paint for 72 hr. at 75 deg. F.

Polyco 556, the latex, is finding widespread usage as a pigment binder—car load quantities of paint containing 556 are being produced. It's compatible with other resinous materials (alkyds) and exhibits freeze-thaw stability: an alkyd modified white formulation withstands six freeze-thaw cycles (16 hr. at 12 deg. F.; 8 hr. at 75 deg. F.) with negligible viscosity increase.—**Borden Co., Chemical Division, New York 17, N. Y.** **148D**

Flatting Agent

Santocel 54 can be stirred into formulations.

New flatting agent requires little or no grinding before it is added to varnish or lacquer preparations. Simple stirring often achieves the necessary dispersion. This means improvement in formulations where excessive grinding lowers flatting efficiency.

Santocel 54, it is claimed, has properties that not only contribute greatly to production efficiency, but continue to let formulators achieve a hand-rubbed quality in the finished product.—**Monsanto Chemical Co., St. Louis 4, Mo.** **150A**

Starch Derivatives

For calender sizing and headbox additive in paper mills.

National Starch has come out with a number of new starch derivatives. All are commercially available.

• One of them—Cato Starch—is a cationic derivative developed for wet end addition on paper machines. It is effective in improving strength factors, such as mullen, fold, tensile and pick at low concentrations on different types of pulp.

Also of interest is the fact that Cato improves sheet formation and produces good drainage on the paper machine wire. This enables operators to increase machine speed without loss in strength.

• The other new products are all carboxymethyl starches, called CM. They range from white to light tan in color and come in three viscosity grades: high, medium and low.

The hydrophlic and excellent film-forming properties of CM starches retard the penetration of such materials as ink, grease and wax. Thus they should find special calendering applications for improving the gloss ink printability of patent-coated boxboard.

Other potential uses include: barrier film on porous board to reduce penetration of subsequent coating materials; tub sizing; beater additive.—**National Starch Products, New York 16, N. Y.** **150B**

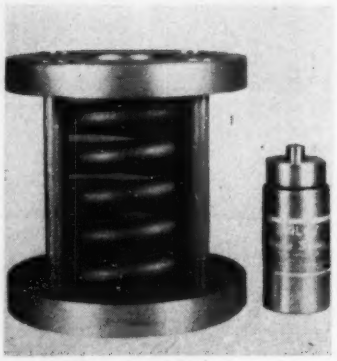
Vinyl Coatings

Protect industrial equipment from abrasion and corrosion.

Two new types of polyvinyl chloride-based protective finishes —vinyl resin-pigment-solvent and vinyl plastisol—can shield metal, wood, concrete and other surfaces. These coatings, called Magic-Vulc, are expected to lengthen service life of tanks, ducts, pipes, fans and blowers.

Flexible fast drying and adhesive, Magic-Vulc vinyl coatings also serve as electric insulators, as material for molding and casting films and for sheets and glass yarn.

The plastisol, although syrupy by nature, is non-volatile—no solvent vehicle is present. Because of this the coating does not shrink when converted to a solid film. One application often gives the thickness desired.—**Magic Chemical Co., Brockton 2, Mass.** **150C**



Silicone Fluids

Feature higher and more stable viscosities, greater resistance to mechanical shear.

New silicone fluids, with viscosities from 1,000 to 100,000 centistokes, are available from GE. Named Viscasil Fluids, they possess properties similar to the lower viscosity silicone fluids but with some qualities—resistance to shear, viscosity stability, heat stability—claimed to be superior to those of other fluids of similar viscosity.

These advantages are being demonstrated particularly well in damping applications: fluid couplings, torsional vibration dampers, time delay relays and shock absorbers like the Wales-Strippit preloaded Hydra Spring *(above, right)*. As a major component of the spring's comproil fluid, Viscasil silicones help provide identical characteristics, with respect to force, stroke, initial and final loads, to those of the big caged railroad-type spring pictured at left. The Hydra Spring can withstand an infinite number of loads and strokes up to the maximum strength of the cylinder.—**General Electric Co., Pittsfield, Mass.** **150D**

Bind Glass to Plastic

Chlorosilanes chemically join glass to plastic, make for greater strength.

Laminated plastics may become more competitive in the auto, boat and airplane industry because of new adhesives being researched now. Known as chlorosilane com-

For More Information . . .

about any item in this department, circle its code number on the Reader Service Postcard inside the back cover.

Customers can depend on DIXIE CHEMICALS

Farmers spray cotton fields with Dixie "Early Crop" to induce earlier harvesting, facilitate picking, and aid pink bollworm control. All drums of "Early Crop" are protected by Tri-Sure Closures.

Fence posts are preserved by soaking them in Dixie "Penta", in a tank formed by welding together two empty drums. "Penta" is always delivered in drums equipped with Tri-Sure Closures.

–always delivered in drums protected by *Tri-Sure*® Closures

AGRICULTURE gets valuable help from Dixie's fine line of chemicals—which includes "Early Crop", the defoliant that speeds up cotton harvesting, and "Penta", the fence-post preservative that also destroys termites.

Farmers *know* they can depend on these and other Dixie Chemicals—shipment after shipment, year after year—because they are *made right* and *protected right*—in drums equipped with Tri-Sure* Closures.

The Dixie Chemical Company uses Tri-Sure Closures to prevent losses in transit . . . as proof of "full value every time" . . . as an expression of regard for every customer. And, in all these ways, oil and chemical companies the world over are proving that it *pays* to insist on the Tri-Sure *Flange*, *Plug* and *Seal*.

Give *your* shipments the security they should have by specifying "Tri-Sure Closures" on every drum order.

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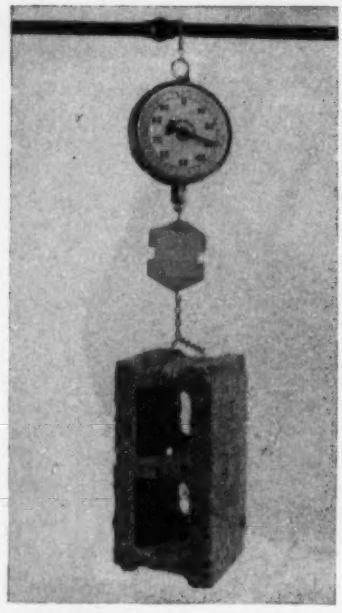
Tri-Sure Products Limited, St. Catharines, Ontario, Canada

pounds (they contain silicon), the new products tightly bind plastic and glass fiber reinforcement together by chemically combining with both of them; the laminates are less likely, then, to separate upon continued vibration or flexing.

Numbering five in all, the binders are allyltrichlorosilane and its reaction products with resorcinol, phenol, m-cresol and xylenol. When tested, all the chlorosilanes lent superior bonding strength to at least one of the commonly used structural resins—polyester, epoxy and phenolic.—**Naval Ordnance Laboratory, Silver Springs, Md.** **150E**



Adhesive

Pressure-sensitive plastic bonds Teflon, resists nearly all acids and alkalis.

Teflon can be joined to metals, glass, paper or to itself with Flexrock No. 80.

This pressure-sensitive adhesive has good acid and alkali resistance and good weathering properties, too, according to initial tests. Effectiveness is maintained throughout a temperature range of —67 to 392 deg. F., even though the product becomes thermoplastic above 300 deg. F. It is affected by most organic solvents, however, and is not recommended for such use.

The product can be applied by brushing or knife coating; it can also be sprayed or dipped when thinned to suitable viscosity. After application, the adhesive must be dried before pressing the two surfaces together. Teflon-to-Teflon peel strengths of approximately 2 lb. per in. of width and sheer strengths of 12-15 psi. are developed. Increased bond strengths can be achieved by lengthening the drying time.—**Flexrock Co., Philadelphia 2, Pa.** **152A**

Polyamide-Epoxies

Possess high flexibility, are useful as protective coatings.

Flexibility is the keynote of a new family of products made by combining epoxy and polyamide resins. Investigated by General Mills for several years, these thermosetting resin blends are proving to be good coatings not only for wood and metal, but also for paper, cardboard, metal foils and plastic film.

These uses are recommended:

- Maintenance finishes—impact-tough, strong adhesive.
- Masonry paints—alkali resistant.
- Electric insulation varnishes —low conductivity.
- Paper coatings—glossy, resistant to vapor, grease and stains.

Use of the polyamide-epoxy resins in adhesives, castings, plastic parts imbedded in electrical equipment and glass reinforced plastics is reported to look promising.—**General Mills, Inc., Minneapolis, Minn.** **152B**

Product Briefs

Isopropylaminoethanols, a blend of isopropyl mono- and diethanolamines, is commercially available. Its oleate soaps show high emulsifying and dispersing power, are effective at IPAE: olic acid mole ratios as low as 1:1. Other features are mild odor, high flash point (155 deg. F) and low toxicity.—**Sharples Chemicals, Inc., Philadelphia 7,, Pa.** **152C**

High mol. wt. polyisobutylenes made in Germany are being sold here in grades of 15,000, 50,000, 100,000, 150,000 and 200,000. Its the first U. S. appearance for the last two. All are useful in adhesive and rubber compounding.—**Nova Chemical Corp., New York 14, N. Y.** **152D**

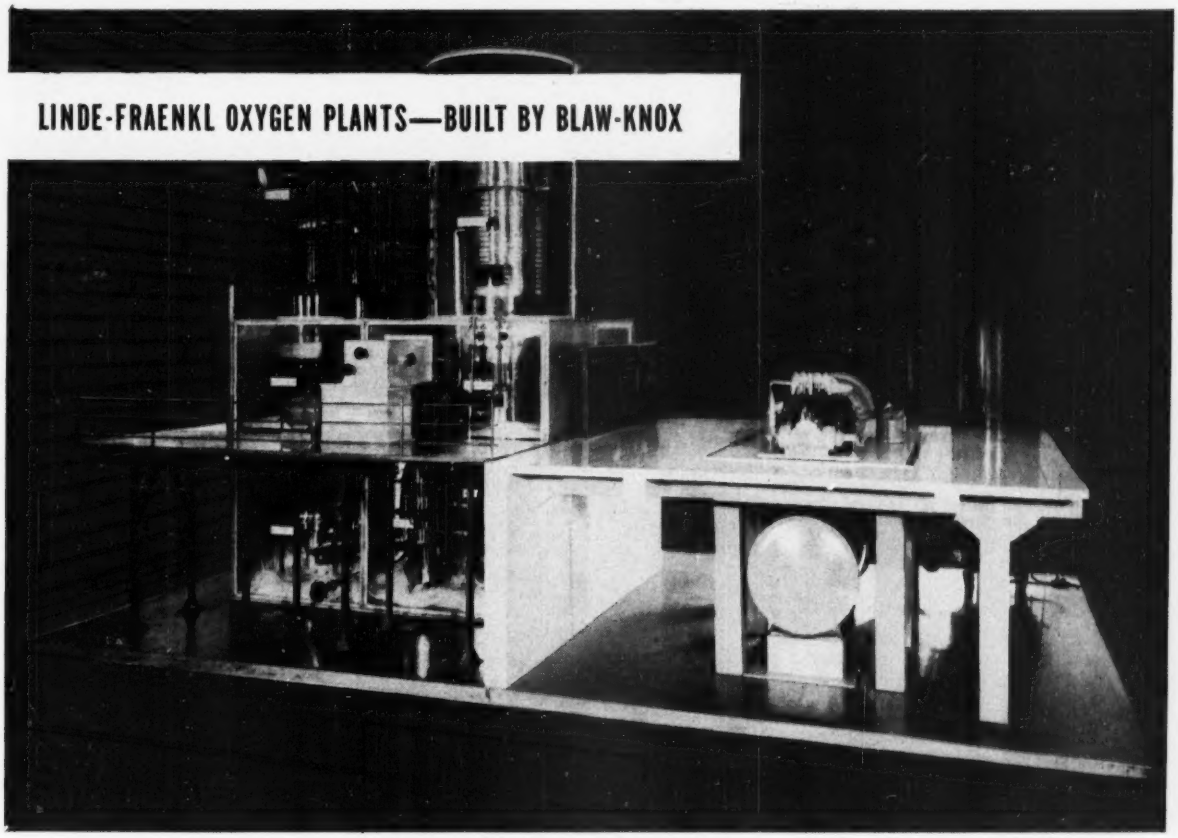
Freon 13 (monochlorotrifluoromethane), a nonflammable, nonexplosive refrigerant for -70 to -150 deg. F., is finding wider usage in metal treatment, chemical processes and testing. It's safe and adaptable to compact, economical, hermetic-type compressors.—**E. I. du Pont de Nemours & Co., Inc., Wilmington 98.** **152E**

Methoxy- and butoxyethyl acrylates are available in pilot plant lots. Copolymers with butadiene show good low temperature properties. When cured, polymers form hard, tough, glossy, non-tacky, insoluble and infusible adhesive films.—**Rohm & Haas Co., Philadelphia 5, Pa.** **152F**

A new, solvent-resistant grease, called Lubricant A-9, is recommended for use in bearings, glands for solvent pumps and valves. It's said to be impervious to any hydrocarbon liquid or gas, and to chlorinated solvents from 20 to 400 deg. F.—**Keystone Lubricating Co., Philadelphia 32, Pa.** **152G**

An adhesive primer for plastic taping, Roybond A-36, is said to increase adherence of tape to pipe by 100 percent. Chemically a polar, synthetic rubber-resin, the primer is compatible with asphalts, coal tar and rubber-type synthetics, will withstand wide temperature variations.—**Royston Laboratories, Inc., Pittsburgh 38, Pa.** **152H**

LINDE-FRAENKL OXYGEN PLANTS—BUILT BY BLAW-KNOX



Scale model representing a 160 ton per day pure oxygen plant now under construction by Blaw-Knox.

all oxygen–99.5% pure at the lowest total operating cost of any tonnage oxygen unit available

Recent design improvements enable new Linde-Fraenkl plants to produce *all oxygen* at 99.5 percent purity at the lowest total operating cost of any tonnage oxygen unit available.

An average power consumption of only 450 horsepower hours is required to produce one ton of 99.5 percent oxygen. Such low power consumption is the result of excellent thermodynamic design and low pressure drops throughout the plant.

Simply designed regenerative heat exchangers maintain extremely close temperature differentials between inlet air and product gases. This is very important when as much as 40 percent of the total refrigeration required can easily result from only a few degrees difference in temperature between these gases. No chemicals are necessary to remove water and carbon dioxide.

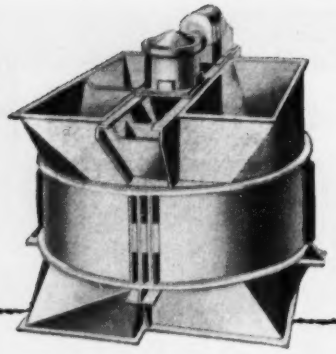
The low pressure requirements of the plant reduce the costs of compressors, drives and auxiliaries.

Because of their advanced design, compact arrangement and relatively few moving parts, Blaw-Knox-built, Linde-Fraenkl units produce more oxygen of greater purity at the lowest total operating cost of any tonnage oxygen plants available. They are ideal for production of argon as a by-product.

If you are interested in low cost tonnage production of oxygen, write for Blaw-Knox Bulletin No. 2402.

BLAW-KNOX

BLAW-KNOX COMPANY *Chemical Plants Division*
Pittsburgh 22, Pennsylvania
Chicago 1, Illinois / Tulsa 1, Oklahoma



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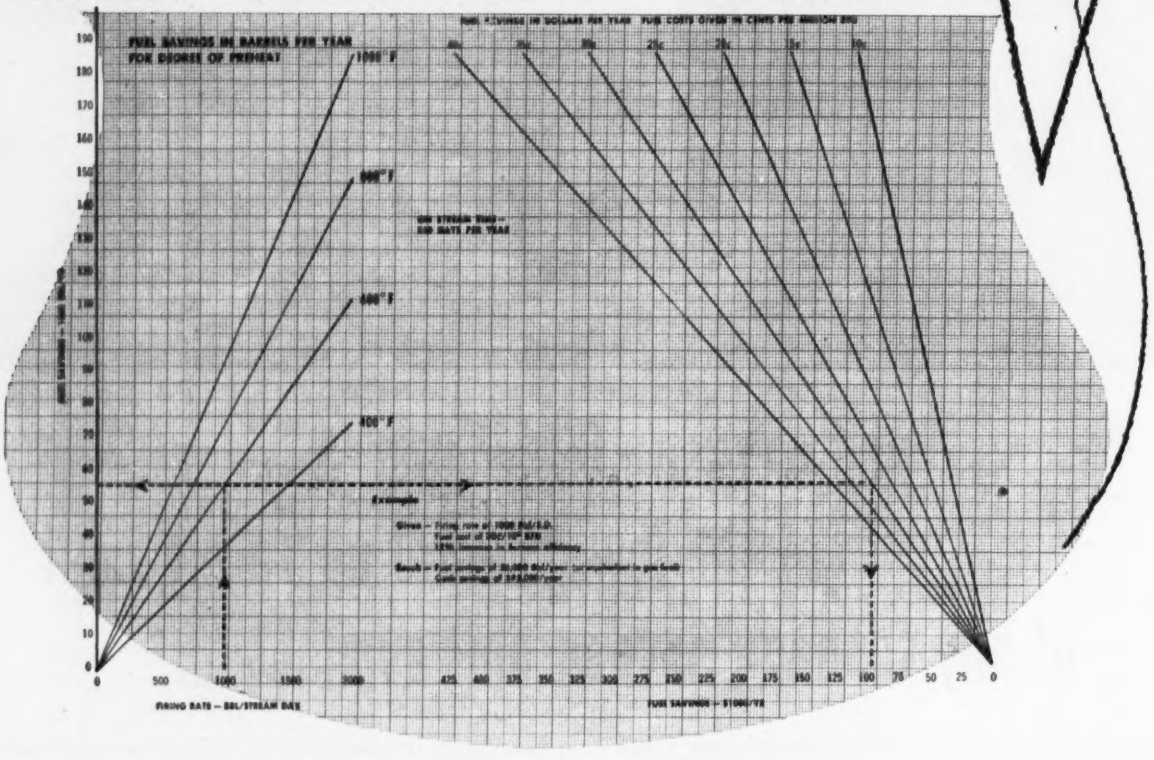
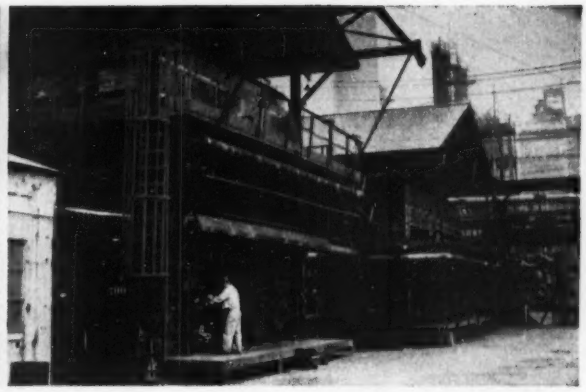


Start at the firing rate in your process units . . . allow a reasonable amount of air preheat (the higher the preheat, the more you'll save) . . . and look to the left for fuel savings. To convert that figure to cash — move to the right to your fuel cost line, and check your savings directly below.

The savings you'll discover for yourself are not fantasy, either. They simply prove why a Ljungstrom Air Preheater will pay for itself in eighteen months . . . a year . . . even nine months or less —in fuel savings alone!

And that isn't all. When you add to this the increased production . . . higher product quality . . . decreased furnace maintenance typical of operations including a Ljungstrom – you'll see why the Ljungstrom Air Preheater can be the oustanding factor in your refinery for *top economy and throughput*. Write today for full details.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

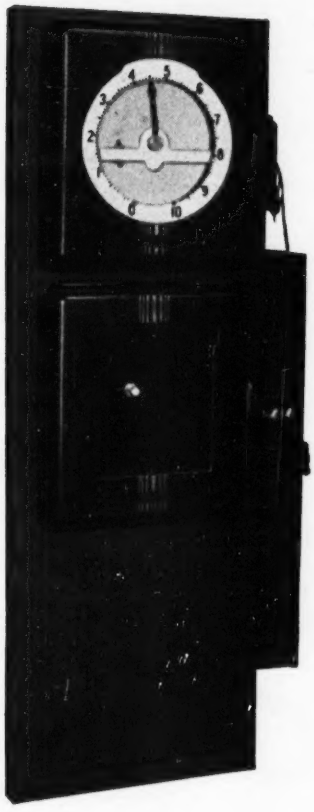


Typical plants where L&N oxygen recording equipment keeps total oxygen completely and accurately recorded, for more efficient combustion control.

Left: A steam central station (boiler furnace in rear) in an eastern utility. Right: A process heater in an eastern oil refinery.

NEW PERFORMANCE for COMBUSTION EQUIPMENT

with the L&N Magnetic Oxygen Analyzer



● Rugged, stable and precise, this unique analyzer detects the percentage of oxygen in flue gas from boiler furnaces and process heaters in oil refineries. Since oxygen is the most reliable index of excess air, especially when firing with mixed fuels, these desirable advantages are now made possible:

(1) combustion efficiency goes up (2) fuel costs go down, and (3) maintenance time is cut to the barest minimum.

To triply assure you of best results, Leeds and Northrup has teamed up this advanced instrument with the Speedomax® Recorder and a sampling unit experience-engineered for reliable operation. This efficient combination offers you this warranted and superior performance:

- **Calibrated Accuracy:** ± 0.15% oxygen against standard gas mixtures
- **Sensitivity:** Better than ± 0.05% oxygen
- **Stability:** Better than ± 0.15% oxygen
- **Speed of Response:** Initial—8 to 12 seconds; 90% of final reading—35 seconds

To revitalize your fuel-burning efficiency, remember that *L&N oxygen* equipment gives you . . . a rapid response to oxygen for *"tight" combustion control* . . . an accurate check on air with *no need for tank samples* . . . the most practical answer to *continuous, trouble-free operation.*

For further information, write to Leeds & Northrup Company, 4916 Stenton Avenue, Philadelphia 44, Pa.

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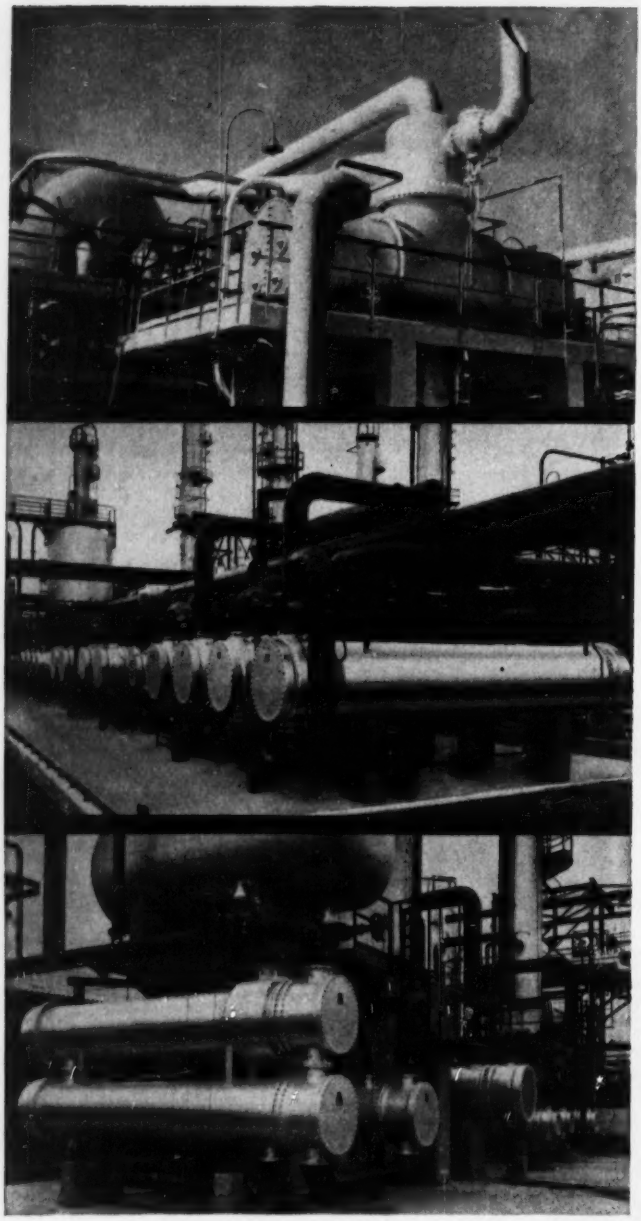

Specially engineered exchangers designed and built by Kewanee-Ross embody features and services that have long been acclaimed throughout the refinery and petrochemical industries. "Bonus values" . . . they're called.

Characteristic Kewanee-Ross standardization is one of them. Substantial delivery time and savings in engineering costs can often be gained through the suitability of standard components for many specially engineered units.

A large stockpile of engineering experience is another. Kewanee-Ross engineers have had long experience with many special and unusual applications. Designing and production are off to a faster start.

Long a leader in the heat exchanger and surface condenser fields, Kewanee-Ross is today in the best position of its history to meet your requirements. Now, with the added capacity of a second large plant (Kewanee, Ill.), recently re-equipped with completely modern machinery and supervised by key "Ross trained personnel," Kewanee-Ross is ideally situated to supply all types of heat exchangers, built to any code, on a very favorable delivery schedule.

Arrange an immediate consultation with the Kewanee-Ross representative nearest you, at your earliest convenience. You have only your time to invest.

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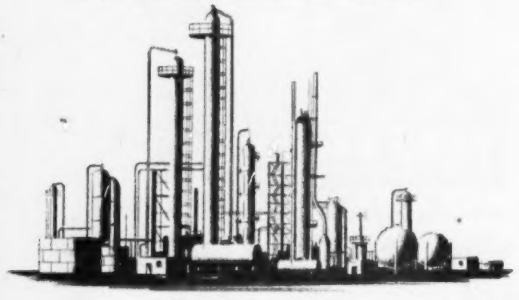

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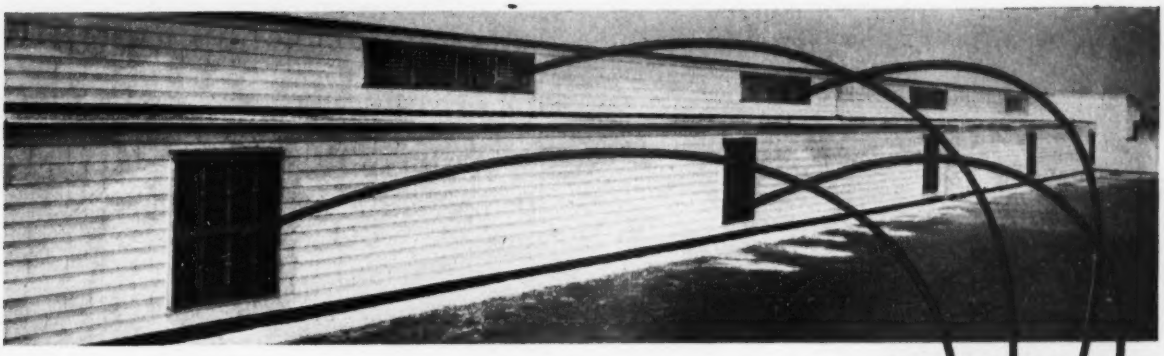
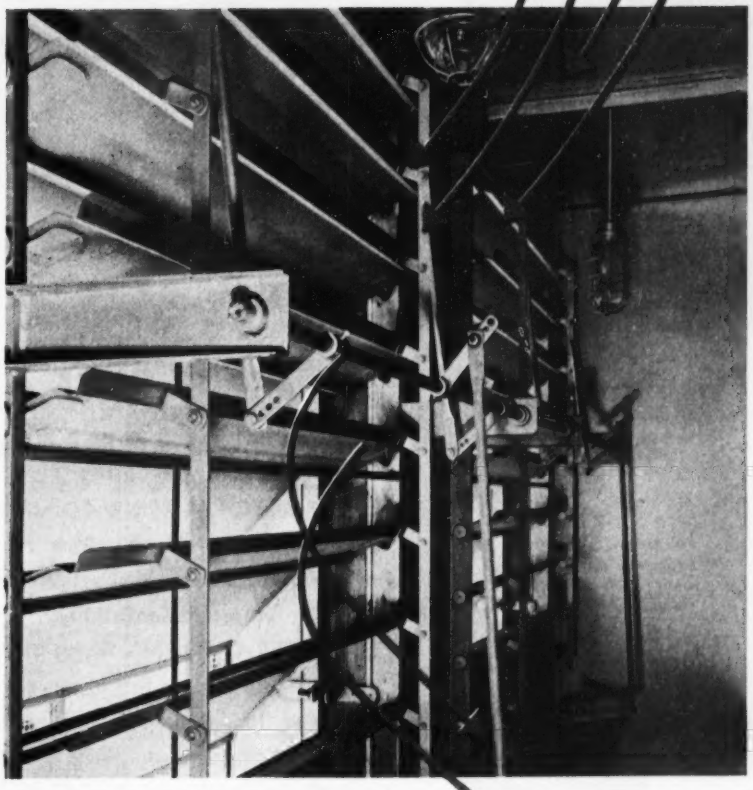


Corrosion is out the window HERE



Photos show air conditioning apparatus house, and fresh air louvre units manufactured by The Bahnson Company, Winston-Salem, N. C. Coatings were formulated by **Specialty Coatings, Inc., Division of Thompson & Co.,** Oakmont, Pa.

The steel framework, fixed louvres, and dampers of this textile-mill air conditioning installation are thoroughly protected with coatings based on BAKELITE Vinyl Resins.

The whole unit is exposed to the outside—to potentially corrosive industrial atmosphere, high humidity, and changeable weather and temperatures. Protection is a must.

That's why coatings based on BAKELITE Vinyl Resins were specified. They can be depended on *all the time*—for high resistance to acids, alkalies and most other chemicals, salt water, industrial gases, and weather extremes. And they adhere tightly to all surface materials . . . even under conditions of expansion and contraction, and resist wear from moving parts.

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AER-O-FOAM's tough blanket of tiny air-filled bubbles smothers and cools fire at the same time. What's more, it can be used to insulate surrounding property and equipment against fire damage. Write for data on AER-O-FOAM (for petroleum fires) and AER-O-FOAM "99" (for polar-solvent or petroleum fires). When you need foam fire protection, you need *fire-tested* AER-O-FOAM protection.

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The service life of your equipment—the efficiency of your production schedules — the ultimate value of your investment and maintenance dollars — all are vitally dependent on the continuing performance of the protective coatings specified in your plant. Thus, success or failure of your coatings can mean the difference between tremendous losses or substantial savings.

To assure coating performance that provides long-lasting, low-cost protection, two steps are absolute essentials, right from the start. You need the right coating for each specific exposure, and it must be applied properly if it is to yield maximum benefit.

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First of all, AMERCOAT provides the right coating for the particular problem. From the complete AMERCOAT line, it is possible to provide specific coatings for specific exposures to achieve specified protective performance.

In addition, you receive the added value of AMERCOAT's conscientious service follow-through backed by an organization SPECIALIZING in industrial corrosion control. With the assistance and on-the-spot advice of a trained representative, you get the best possible application through proper attention to surface preparation and correct coating techniques.

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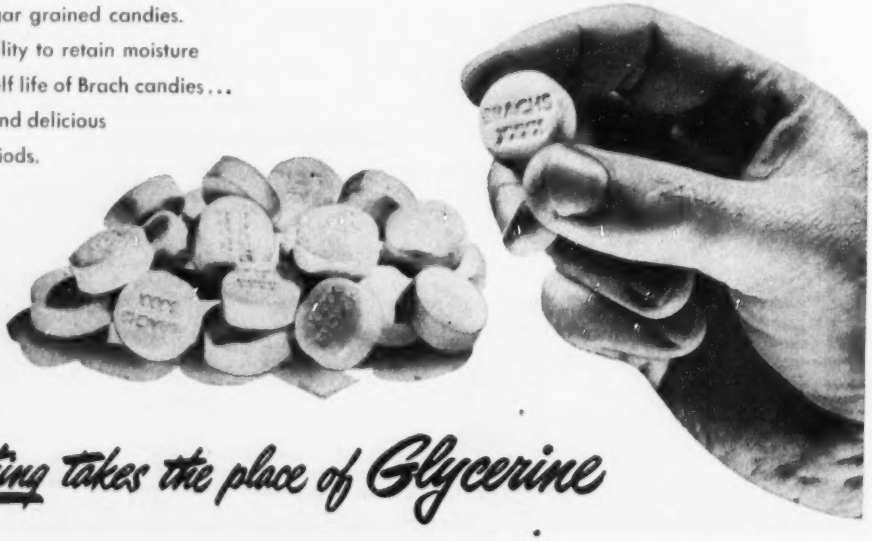
For over a quarter of a century, E. J. Brach & Sons, Chicago candy makers, have used U.S.P. Glycerine in marshmallows, lozenges, and pure sugar grained candies. Glycerine's ability to retain moisture lengthens the shelf life of Brach candies... keeps them fresh and delicious for much longer periods.

Keeping foods fresh by its ability to retain moisture is only one element of Glycerine's value to food manufacturers. In candy, for example, Glycerine acts not only as a humectant but also lends smoothness to mixtures, helps to assure more uniform distribution of flavorings, and contributes to palatability.

In compounding flavoring preparations, Glycerine often acts as a solvent, and at the same time adds body to the product. Glycerine is used—as a plasticizer—in the manufacture of meat casings, both animal- and cellulose-type. Glycerine is also used as a plasticizer in many food wrapping materials, such as cellophane and vegetable parchment.

In dozens of other food applications, Glycerine's unique range of properties and freedom from toxicity make it an outstanding favorite. The free booklet, "Glycerine . . . Preferred for Product Conditioning," contains helpful data on Glycerine properties and applications. For your copy, write Glycerine Producers' Association, 295 Madison Avenue, New York 17, N. Y.



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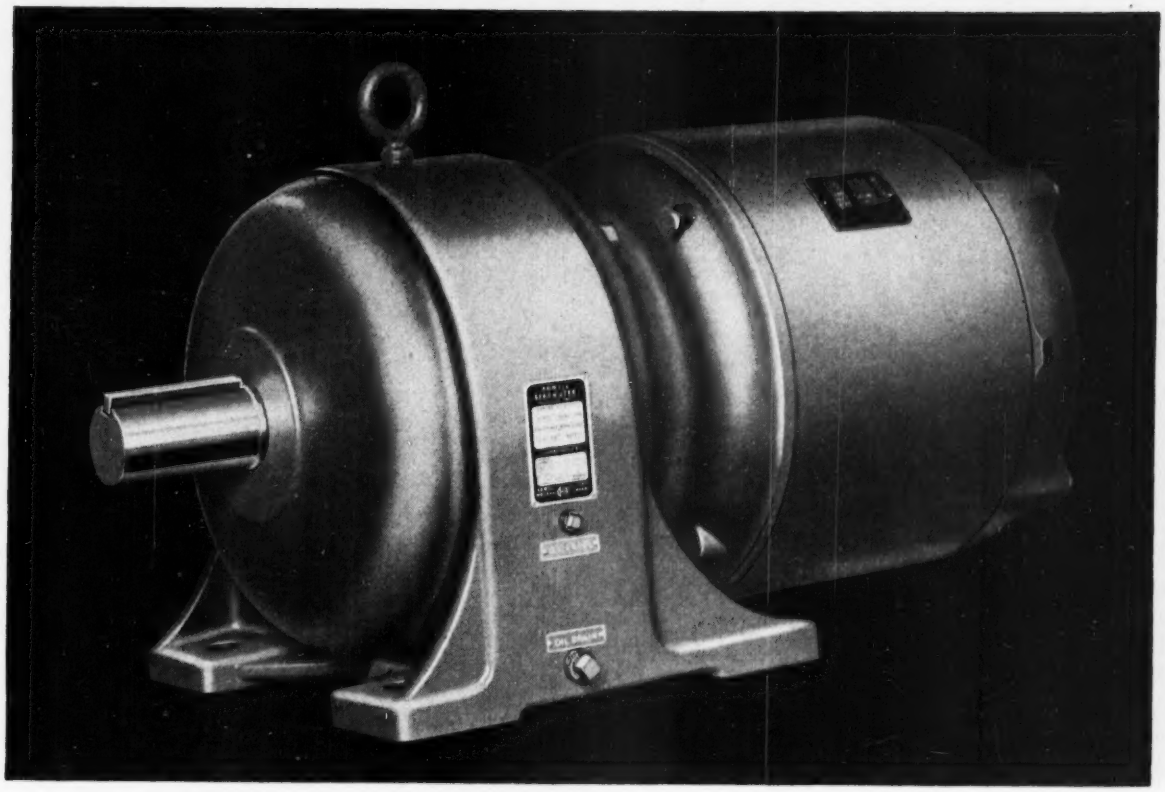

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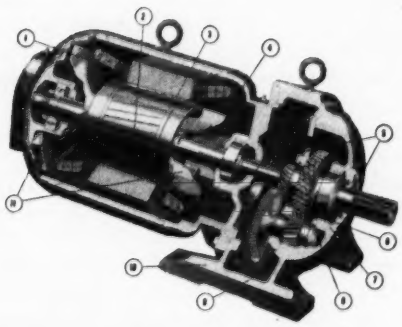

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5. Leakproof oil seals
6. Duti-Rated Lifetime Gearing
7. Unit case construction with integral bearing housings
8. Corner-mounted offset shaft
9. Large oil reservoir
10. Heavy, cast-iron construction
11. Superior cooling

New dependability, greater starting torque and top efficiency, with output speeds as low as 7.5 rpm. are now available in Howell Gear Motors.

This compact, single-unit motor may well be the answer to your gear reduction problems. Combining the finest in heavy duty industrial gearing with the best in motoring, Howell Gear Motors reduce drive failures and production downtime.

Howell Gear Motors use duti-rated, lifetime gearing, with file-hard tooth surfaces and tough, resilient cores. They are available in all types of enclosures, from 7.5 to 780 rpm. with a capacity range from 1 to 30 hp., in all three AGMA service classifications.

For full information on Howell Gear Motors, contact the Howell man in your area, or write the factory direct for Bulletin GM-1.

HOWELL Red Band MOTORS

HOWELL MOTORS

HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN

MOTORS FOR INDUSTRY SINCE 1915

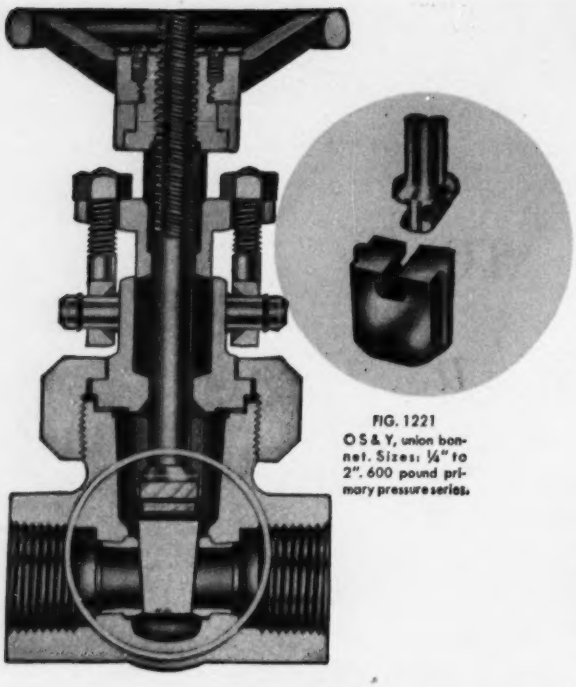


FIG. 1221
O S & Y, union bonnet. Sizes: ¼" to 2". 600 pound primary pressure series.

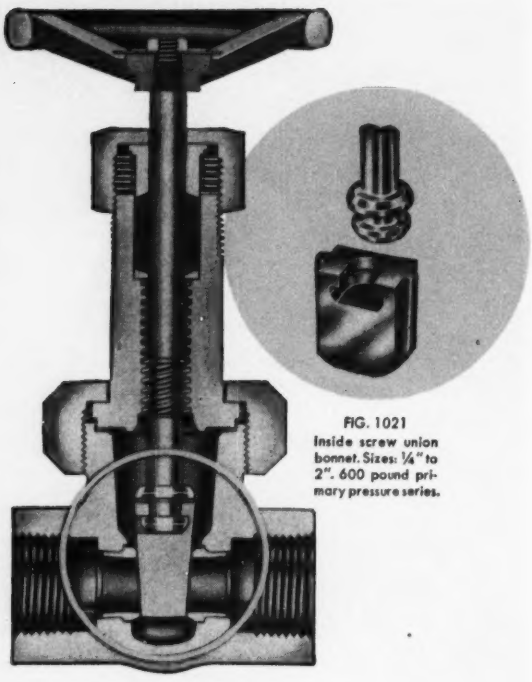


FIG. 1021
Inside screw union bonnet. Sizes: ¼" to 2". 600 pound primary pressure series.

New design makes OIC forged steel gate valves the most modern line . . .

NEW: stronger stem-to-wedge connection. Improved, modern design increases pull-out strength to many times the theoretical requirement. This design distributes the pull-out load more efficiently throughout the wedge structure to meet the most stringent specifications of valve buyers in all fields.

NEW: wedges wear longer. Wedges are made of 13% chrome stainless steel for corrosion resistance. They are duracased to at least 1000 Brinell Hardness to prevent galling and excessive wear caused by frequent closures upon foreign particles in the flow.

NEW: union bonnet design is more efficient. Body-to-bonnet joint of the male-female type provides a recess for the gasket. It is contained more securely, reducing the possibility of leakage or a blown gasket.

OTHER OUTSTANDING FEATURES

Stem threads of all OIC inside screw, forged steel valves are always contained inside the bonnet. They can't possibly load up with corrosive matter which might be in the flow. This keeps the threads clean and free running, and contributes to longer stem wear.

Modern OIC Seal-Ever packing is a special composition which eliminates electrolytic action between the stem and the packing. This prevents stem corrosion in the packing area and helps maintain a leakproof seal.

Back-seating feature provides means of repacking valves while in service.

OS & Y valve gland "I" bolts are retained on trunnions by modern, more efficient, stainless steel snap rings.

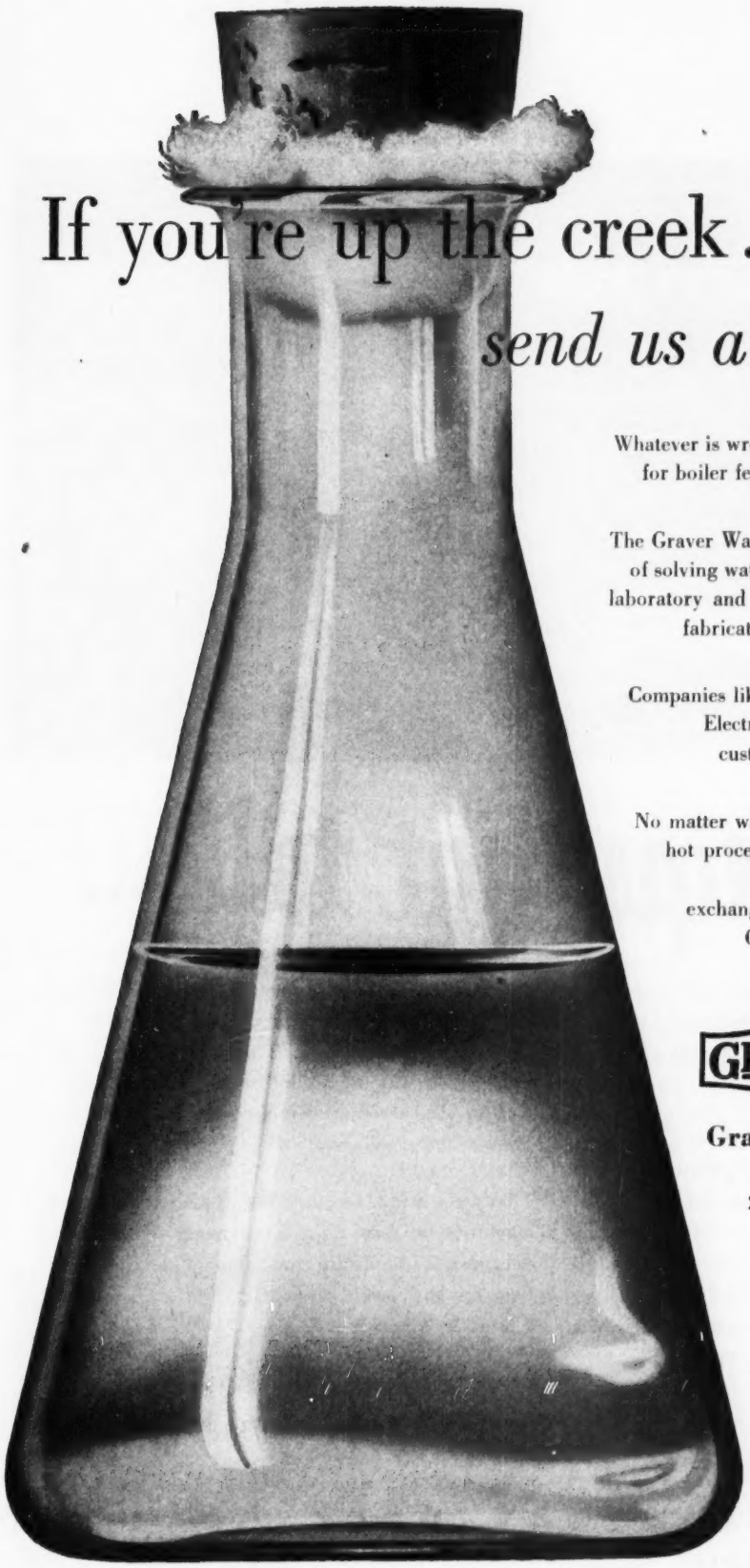
Shoulder-type seat rings are expanded into the body under heavy pressure. They are accurately machined to mate tightly with the wedge for a positive seal.

Order modern OIC Forged Steel Valves from your nearby OIC Distributor. Write and request Folder No. 195.

OIC Forged Steel Valves are also available in globes, angles and checks in a variety of trims for any service.

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

OIC VALVES | **FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON**



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Whatever is wrong with your natural water supply . . . for boiler feed, for process, for almost any purpose . . . there's an answer to the problem.

The Graver Water Conditioning Co. is in the business of solving water treating problems . . . with research, laboratory and pilot plant testing, equipment design, fabrication, erection services, whatever it takes to give you the water you need.

Companies like Esso, Dow, U. S. Steel, Philadelphia Electric, and Procter & Gamble are Graver customers. They wouldn't be if we didn't know our business.

No matter what process or product is required . . . hot process-hot zeolite softeners, Reactivators®, filters, deaerators, demineralizers, ion exchangers, clarifiers, or what have you . . . Graver equipment, backed by 40 years of experience, can help. We will do the whole job or any part of it, from problem through planning to erection.

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● *Go to Graver for Water Conditioning*

The chips that talk...

To the native savage, whose tribe had no conception of a written language, the piece of wood on which the explorer scribbled a message became the wonderful "chip that talks."

The chips of metal that pour in silver drifts from the mighty machines in Sun Ship's Wetherill plant tell their stories, too. Those shown on the 14-foot boring mill tell part of the story of a fast, thorough repair job on ship-propulsion machinery. That job required lifting a 54-ton section of crankshaft from the ship to a 10 ft. x 50 ft. engine lathe, where it was checked for trueness and the journals machined. The crankpins were machined in a huge crankshaft machine. The boring mill operation shown was the facing of the webs of a new section which replaced one of the damaged sections of the crankshaft.

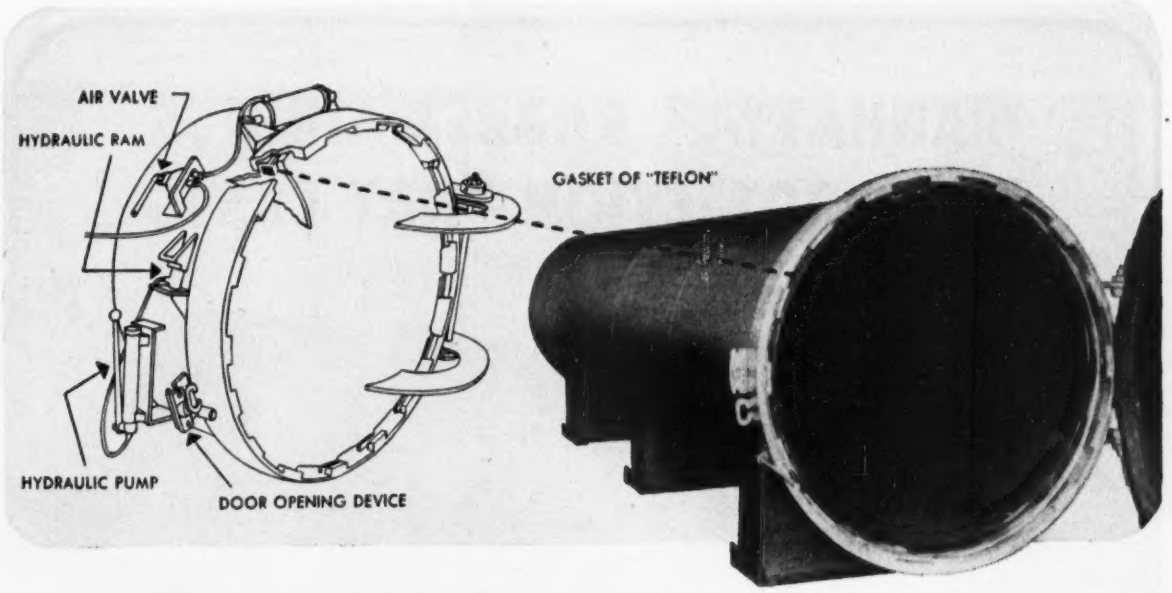
That's the kind of story the versatile men and machines at Sun Ship have been writing for decades . . . in building special machinery of every type for the varied industries that are building a greater America.

Sun

SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE SINCE 1916 **CHESTER, PA.**

25 BROADWAY • NEW YORK CITY



Gaskets of Du Pont "Teflon" resist heat and wear for pressure and vacuum vessels

Reduce gasket replacement cost

Gasket replacement costs for Tharco Quick-Opening Safety Doors have been cut to a minimum. These doors, used for pressure and vacuum vessels, now feature heat-resistant, wear-resistant gaskets of Du Pont "Teflon"* tetrafluoroethylene resin.

The gaskets of "Teflon" seal without any internal pressure. And Du Pont "Teflon" has a combination of properties available in no other single material. It resists temperatures as high as 500°F ... is mechanically strong ... and is non-contaminating and inert to all chemicals except molten alkali metals and fluorine under elevated temperatures and pressures.

Have you and your company investigated the properties of Du Pont "Teflon" and the other members of the Du Pont family of plastic engineering materials—"Alathon"* polyethylene resin, "Lucite"* acrylic resin, and "Zytel"* nylon resin? The application described above is typical of the product improvement made possible when design and service requirements are evaluated in terms of the properties of these unique engineering materials. For further information, clip the coupon.

*TRADEMARK OF E. I. DU PONT DE NEMOURS & CO. (INC.)

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TEFLON®
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... through Chemistry

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Please send me more information on the Du Pont plastic engineering materials checked: ☐ "Teflon" tetrafluoroethylene resin; ☐ "Alathon" polyethylene resin; ☐ "Zytel" nylon resin; ☐ "Lucite" acrylic resin. I am interested in evaluating these materials for_____

*Name*_____

*Title*_____

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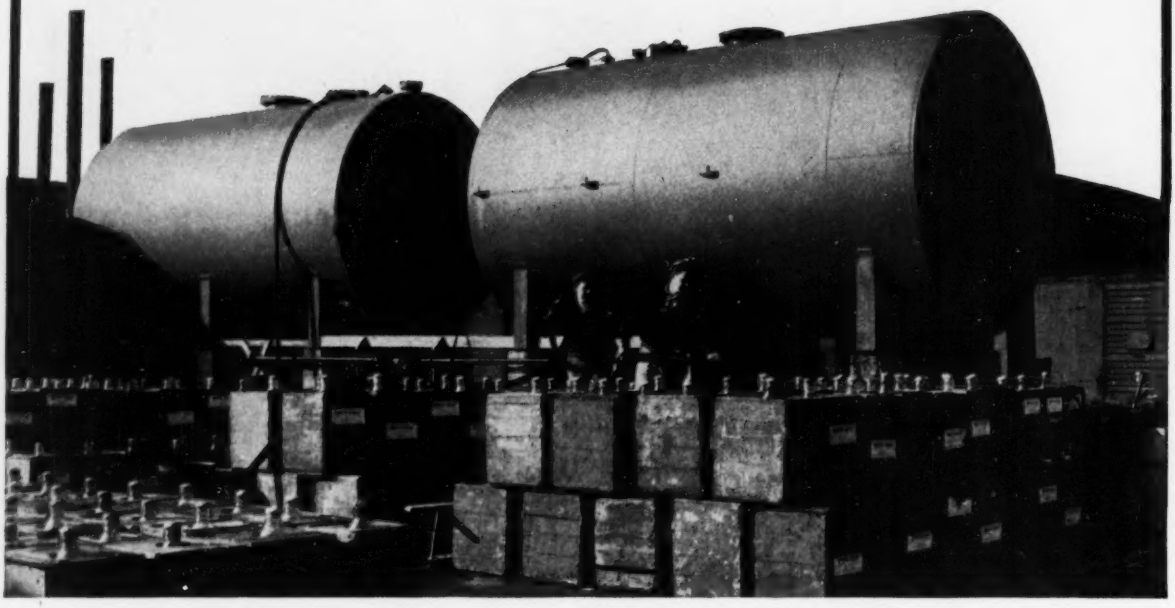
*State*_____

*Type of Business*_____

MANHATTAN RUBBER LININGS FOR PROTECTION THAT LASTS



You get long-life protection against metal corrosion and product contamination with Manhattan Rubber Linings. Manhattan craftsmen apply natural or synthetic rubber in thick, calendered sheets to produce a homogeneous rubber-to-metal bond that cannot be physically separated. Manhattan Rubber Lining on your tank expands and contracts with the metal under temperature changes without hardening or cracking. It presents a resilient, non-breakable surface that effectively resists abrasion, knocks of ordinary usage. And to doubly assure satisfactory results, your Manhattan Rubber Lined Equipment is tested dielectrically under 15,000 volts. • This Manhattan method of rubber lining means permanent protection from corrosion of costly steel tanks and equipment . . . positive protection against contamination of process fluids used in your operations. It's a method based on more than 60 years of experience in quality rubber engineering craftsmanship. Let a Manhattan lining engineer show you how to get life-time protection against corrosion with Manhattan Rubber Lined tanks, pipe, fittings, extractors, evaporators, etc., for the chemical industry.

RUBBER LINING PLANTS AT PASSAIC, N. J. AND NORTH CHARLESTON, S. C.

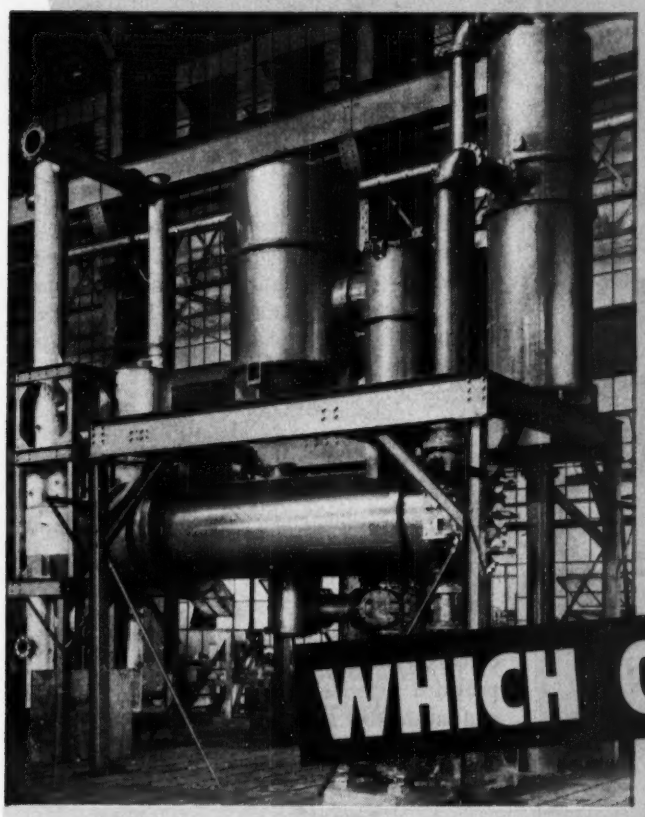
R/M

MANHATTAN RUBBER DIVISION—PASSAIC, NEW JERSEY

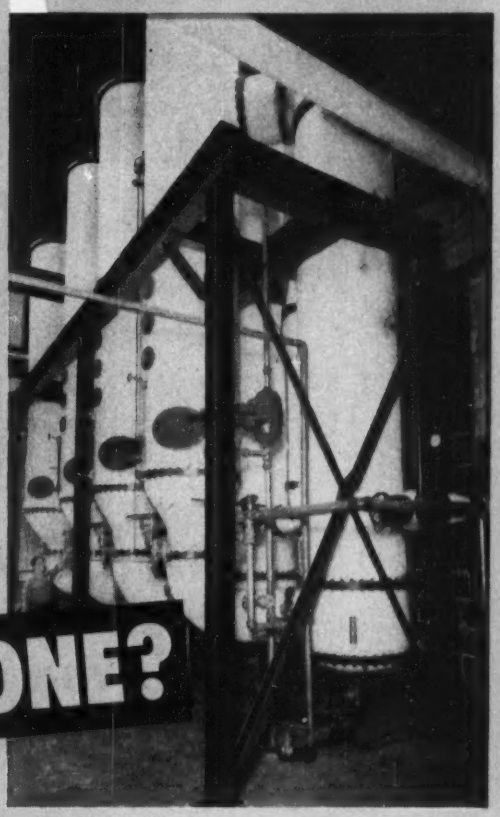
RAYBESTOS-MANHATTAN, INC.

Other R/M products include: Industrial Rubber • Fan Belts • Radiator Hose • Brake Linings • Brake Blocks • Clutch Facings Asbestos Textiles • Packings • Engineered Plastic, and Sintered Metal Products • Bowling Balls. RM-423

An example of BUFLOVAK Forced Circulation and V.R.C. (Vertical Rapid Concentration) Evaporator. This one is used for concentrating a citrus by-product.

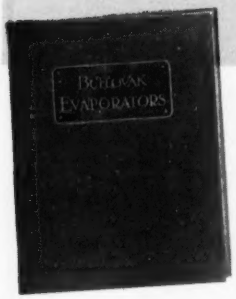


An example of BUFLOVAK Natural Circulation Type Evaporator. This is a Quadruple Effect used to concentrate a food product. Automatically controlled.



WHICH ONE?

each evaporator problem has one best answer



BUFLOVAK catalogs have a wealth of valuable information for you on drying, evaporation and processing. A request on your company letterhead will bring copies to you.

If *you* have an evaporator problem it must be treated individually . . . *if* you want the most profitable return on your invested dollars.

BUFLOVAK Vertical Rapid Concentration Evaporators provide high rates of evaporation, maximum recovery of solids, with simple, easy operation. You can pre-test in the BUFLOVAK Testing Laboratory in order to be doubly sure. Your engineers and ours do the testing, or we do it for you. Recommendations follow, based squarely on the results obtained.

BUFLOVAK V.R.C. Evaporators offer many operating advantages in concentrating liquids which do not precipitate crystals during concentration. Particularly, heat-sensitive materials, foamy liquids, and products requiring sanitary operation. Other types of BUFLOVAK Evaporators are available also, to serve every industry where liquids must be concentrated.

All BUFLOVAK equipment is designed, built, guaranteed and serviced by BUFLOVAK. Every manufacturing operation is performed in our own shops. We're ready to help you with your processing problems, regardless of the nature of the product or the result desired.

THE BUFLOVAK ANSWER
is based on lowest overall operating cost

BUFLOVAK EQUIPMENT DIVISION
OF BLAW-KNOX COMPANY
1551 Fillmore Avenue, Buffalo 11, New York

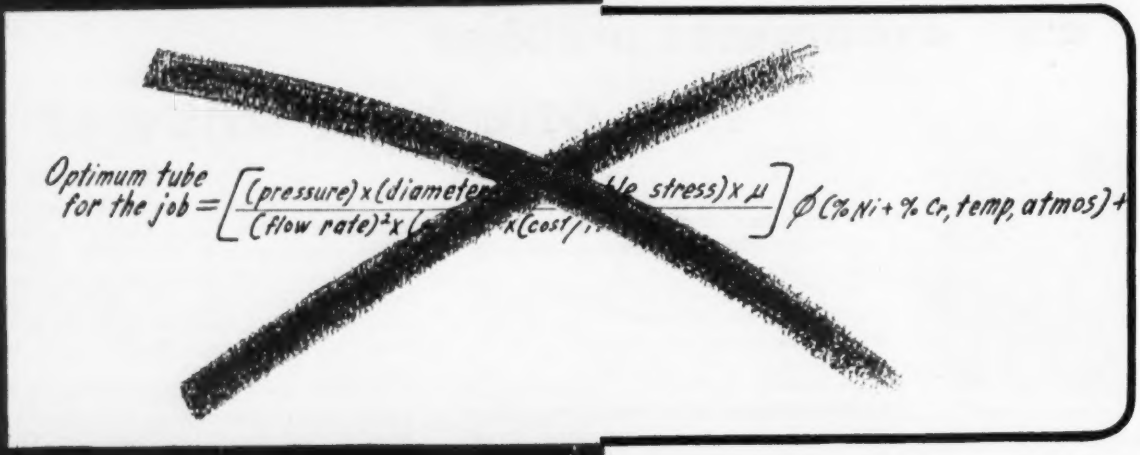
BLAW-KNOX

WHEN PRESSURE IS PARAMOUNT

Tube Selection Cannot Be Reduced to a Formula—Even a Complicated One

The choice of the optimum tubing to use in an application requiring the handling of a specific fluid at a definite working pressure involves the consideration of a number of factors. In addition to temperature, tube size, and mechanical strength of the steel, such factors as the type of fluid and corrosion resistance of the steel must be considered.

A typical case of the importance of these two factors involved an installation of Type 347 stainless steel. The tubing was exposed to chloride-bearing bayou water while conveying methanol and unreacted synthesis gases at 300F and 5000 psi. The chloride solution caused pitting corrosion. The stresses became localized at the root of the pits and reached a sufficient magnitude to cause stress corrosion and failure. Croloy 5, subsequently used, provided superior resistance to the initial pitting and satisfactory service at the desired temperature and working pressure and also at a considerable savings in cost of the tubing.



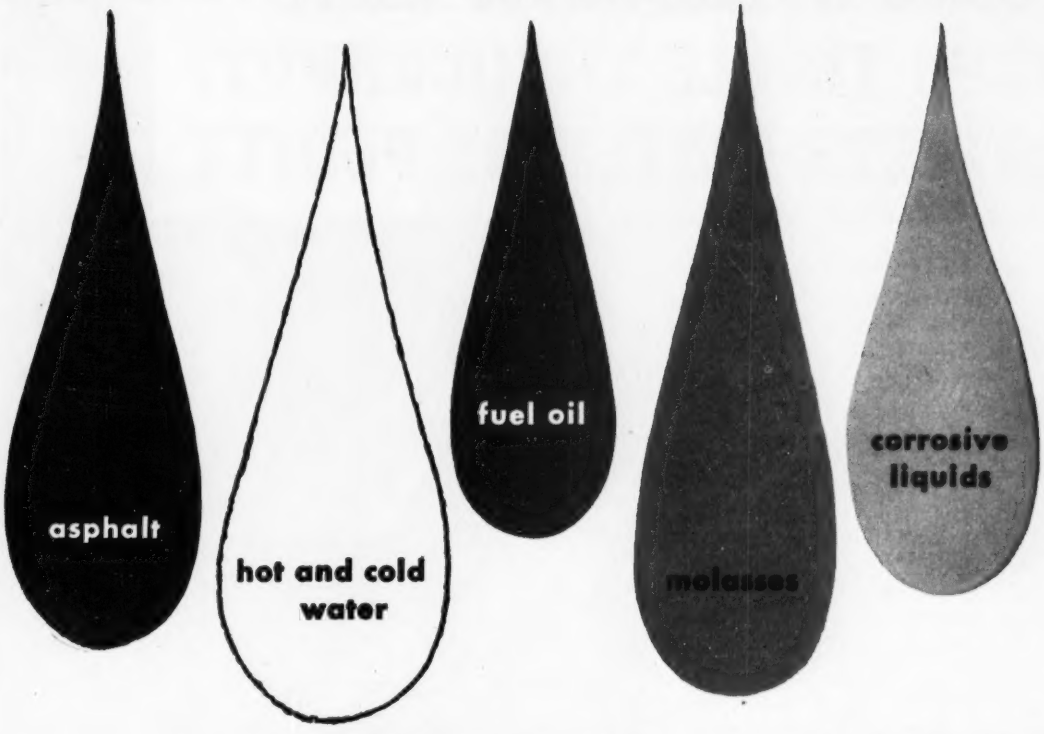
B&W STAINLESS and WELDED TUBES

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION

It takes an expert to specify the optimum tubing for any particular application. And there is no substitute for the kind of experience with such problems you'll find at B&W. To get the most benefit from B&W's long experience in matching tubes to jobs call on Mr. Tubes, your nearby B&W Tube Representative. He can help you.

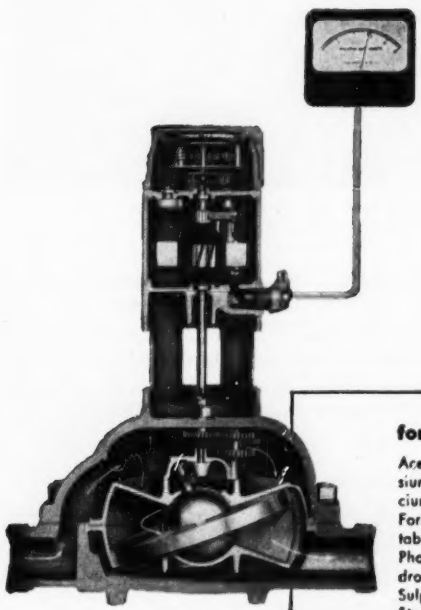
TA-4024 (P)

viscosities unlimited



HAYS VERIFLOW METER AND HAYS ELECTRONIC VERITROL

indicate and control liquid flow



Now virtually all fluids can be precisely measured and accurately controlled—*from a remote position.*

Hays VERIFLOW meter accurately measures, indicates, and totals the flow of corrosive and hard-to-meter liquids without using weigh tanks, orifice plates, or gage sticks.

With the Hays VERITROL you simply set a knob at the rate of flow desired . . . then, the VERITROL controls the flow of liquid at that set-rate.

Send for a complete description of Hays Veriflow Meter and Veritrol, Pub. No. 53-766-38.

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Acetic Acid, Aluminum Potassium Sulphate, Ammonia, Calcium Compounds, Carbolic Acid, Formaldehyde, Fruit and Vegetable Juices, Hydrogen Peroxide, Phosphoric Acid, Potassium Hydroxide, Sodium Compounds, Sulphuric Acid (concentrated), Stearic Acid, and many others.

Automatic Combustion Control
Boiler Panels • Hays-Penn Flowmeters
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Electronic Feed Water Controls
Miniature Remote Indicators

THE hays CORPORATION

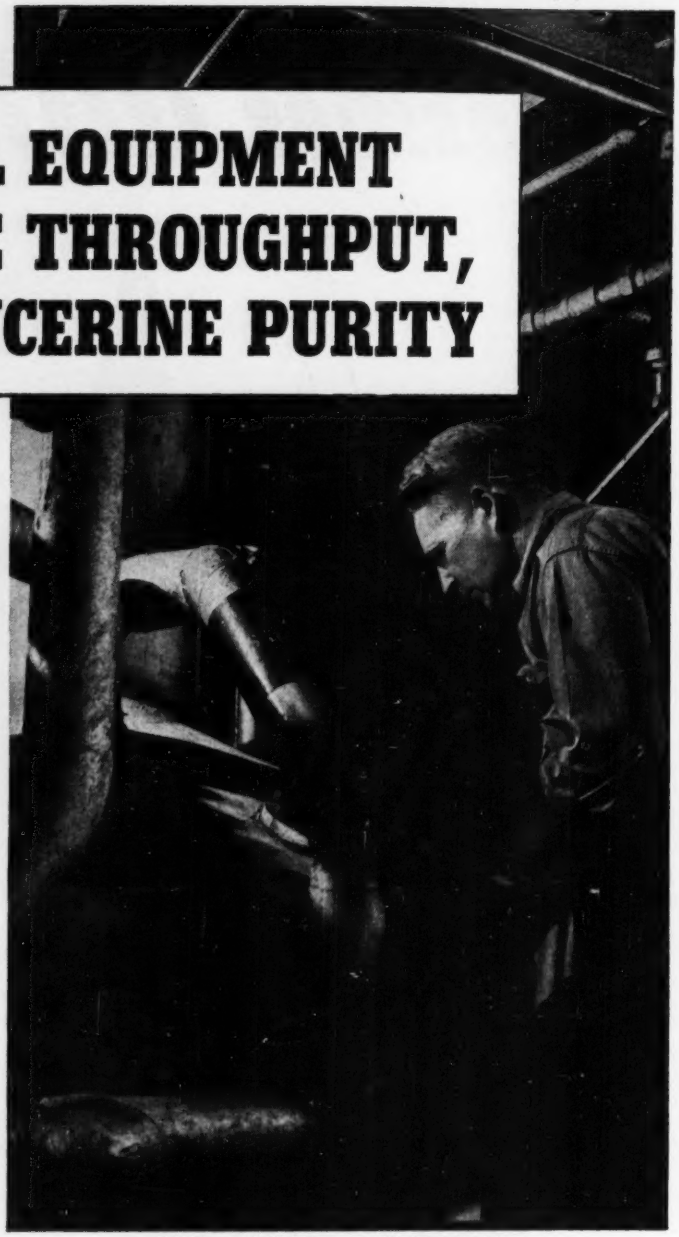
MICHIGAN CITY 9, IND.

CLAD STEEL EQUIPMENT HELPS TRIPLE THROUGHPUT, PROTECTS GLYCERINE PURITY

Even after slow and costly distillation, this soapmaker was plagued by poor quality "yellow distilled" glycerine. Then a new distillation unit was designed featuring a still pot with solid nickel coils for faster heating, nickel-clad steel shell for vital corrosion resistance. Results: redistillation eliminated, throughput tripled, and a 70% cut in fuel costs which saved $7,000 a year.

The advanced design of this new equipment called for both the performance and economy of clad steel. Nickel cladding, inseparably bonded to the lower cost carbon-steel backing, does the work of expensive, solid high-alloy in plate form at substantial savings. Clad's corrosion resistance protects the product *economically*, assuring that it will be pure and free from contamination. Important also, the still has the strength needed to withstand high vacuum operation.

Equipment performance like this results from teamwork between the equipment builder and design and production engineers. Are you looking for maximum productivity . . . low-cost, trouble-free operation . . . and long equipment life? You'll find that sound engineering and modern fabrication techniques employing versatile clad steels can provide these advantages for you. It pays to consult your fabricators *early* in your planning. They will work with your engineers and consultants, can often provide cost-saving suggestions in giving you the specialized equipment you want.



Multiple distillation was eliminated with this new corrosion-resistant clad steel still.

Ask one of your fabricators to show you the new Lukens clad steel movie, "Equip for New Profits." Here—in full color and sound—are factual accounts of how clad steel equipment brings new economies. Its story contains ideas of interest to everyone concerned with production efficiency and economy. Or contact Manager, Marketing Service, Lukens Steel Company, 678 Lukens Building, Coatesville, Pa.

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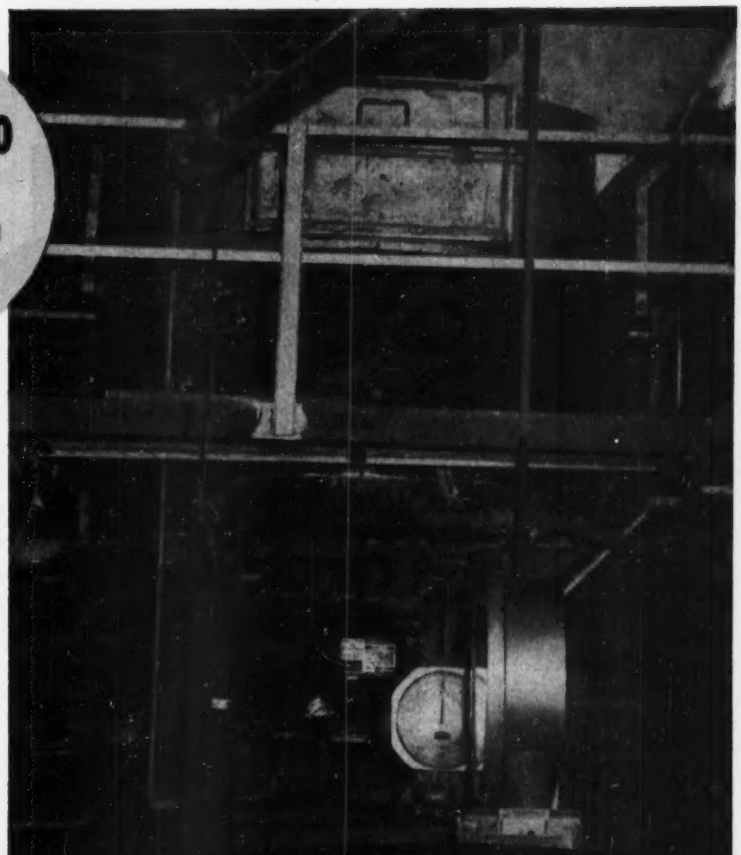
PRODUCER OF THE WIDEST RANGE OF TYPES AND SIZES OF CLAD STEELS AVAILABLE ANYWHERE



$20,000.00 SAVED IN PRODUCTION COSTS IN 3 YEARS

CLAY PREPARATION TIME CUT FROM 6 DAYS TO 45 MINUTES

MAINTENANCE COSTS REDUCED 75%

...all with 1 SIMPSON Mix-Muller in a DRY MIX process!

DO YOU KNOW WHAT MULLING IS?

Watch the practiced technique of a chemist's mortar and pestle—the intensive rubbing and smearing actions—and basically, THAT'S MULLING!

Mulling with a SIMPSON Mix-Muller utilizes a special pair of revolving mullers and plows mounted on a stationary pan. The mullers are adjustable and are supported by rocker arms. This leaves them free to ride on the material, creating a true mulling action as they revolve. The results are thorough, more rapid blending.

PASS & SEYMOUR, INC., well-known electrical porcelain producers of Syracuse, N.Y. have tested and proved beyond doubt the time and money saving advantages of using a Simpson Mix-Muller in the key spot.

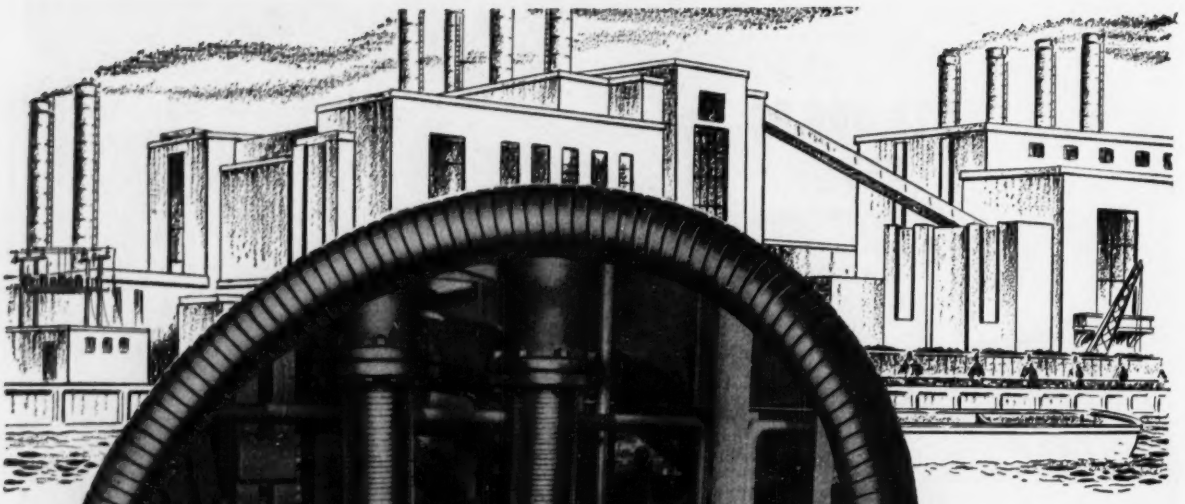
As compared with previous clay preparation methods, here are some of the benefits gained since their Simpson was installed three years ago: *$20,000 savings in labor and production cost; Former time of five to seven DAYS to produce dry press clay body cut to 45 MINUTES; Simpson Mix-Muller has cut former maintenance costs by 75%, with NO major repairs required in three years.*

If you are looking for ways to save time and money in mixing ANY dry, semi dry or pasty material . . . you can't afford to overlook the time tested and *proven* advantages of mulling in a Simpson Mix-Muller.

A letter or phone call will put our years of specialized experience at your disposal.

SIMPSON *MIX-MULLER*® DIVISION

NATIONAL ENGINEERING CO., 636 Machinery Hall Bldg., Chicago 6, Ill.
(Not Inc.)



Penflex flexible expansion joints installed on safety blow-off valves above superheaters in big West Coast power plant.

FLEXIBLE PENFLEX STANDS STEAM SHOCK

PENFLEX TUBING ABSORBS THERMAL EXPANSION . . . PREVENTS BLOW-OUT

Without warning, the safety valves atop these big superheaters suddenly pop. A mighty surge of 900 F, eight-hundred-and-fifty-pound steam blasts through the pipes to exhaust to atmosphere. These pipes have to know how to take it!

Ordinary rigid pipe would blow apart under the terrific thermal expansion. But Penflex flexible metal tubing has enough "give" to take the shock. Six lengths of 8" Penflex interlocked tubing installed as expansion joints on the boiler blow-off line cushion the sudden impact . . . take up any pipe movement due to extreme temperature and pressure changes.

Penflex engineers can help you solve your tough tubing problems. Penflex makes a complete line of 4-wall interlocked and seamless welded corrugated tubing . . . metallic hose, tubing and couplings from ⅛" I.D. up . . . automatic barrel fillers, pneumatic rivet passers, accessories and fittings. Write for illustrated folder "Flexineering." It's a valuable production aid.

Pennsylvania Flexible Metallic Tubing Company, Inc., 7234 Powers Lane, Phila. 42, Pa.
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penflex

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CHEMICALS

INDISPENSABLE TO INDUSTRY
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In the United States and Canada, Bechtel is happy to be of service to The Dow Chemical Company, major producer of industrial, agricultural and fine chemicals, plastics and magnesium.

As engineer and constructor for the chemical companies Bechtel Corporation is helping the fastest growing of all industries to meet the demand for modern chemical products. Experience, and the size and flexibility of the Bechtel organization provide important advantages when plans for expansion are ready for action.

BECHTEL

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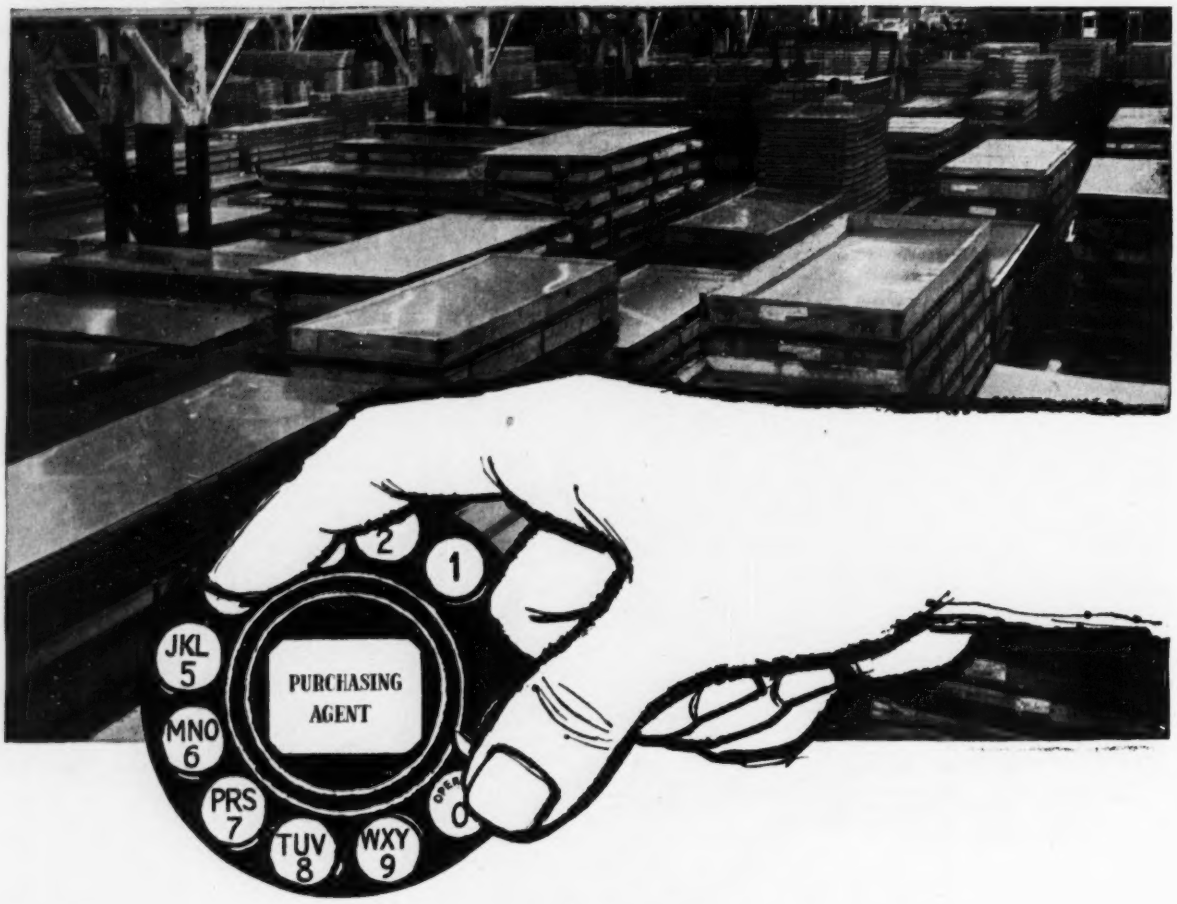

Stainless steel . . .

world's largest stock at your finger tips

There IS a difference in your sources for stainless steels and not the least important difference is that Ryerson carries more tonnage in more types, shapes and sizes than any other source. Stocks include stainless to ASTM, MIL-S and AMS specifications. Many requirements are available only from Ryerson.

You'll find this to your advantage whether you need a single piece or a carload, for you're sure of getting immediate delivery on your exact specification with a single call. And you're sure of quality, too, because all Ryerson stainless is time-tested Allegheny Metal, kept in prime condition in clean, heated rooms—prepared to your order on special equipment unequalled in the industry.

Since we were the first steel-service company to carry stainless in stock, we've had almost 30 years of experience in helping industry in the use of these unique heat and corrosion-resistant alloys. So when you need stainless, get *complete* stainless service with immediate delivery from the world's largest stocks . . . call Ryerson.

In stock: Bars, structurals, plates, sheets, tubing, alloys, stainless, reinforcing, machinery & tools, etc.

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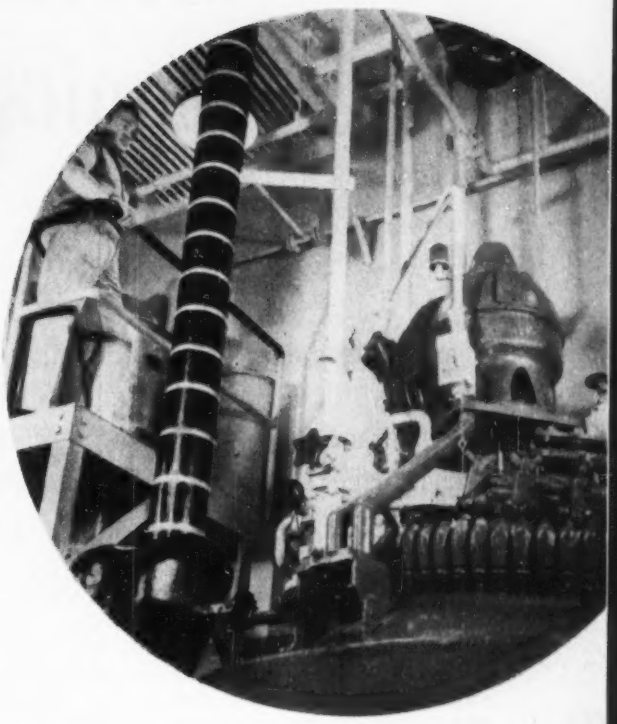
JOSEPH T. RYERSON & SON, INC. PLANTS AT: NEW YORK • BOSTON • PHILADELPHIA • CHARLOTTE, N. C. • CINCINNATI • CLEVELAND
DETROIT • PITTSBURGH • BUFFALO • CHICAGO • MILWAUKEE • ST. LOUIS • LOS ANGELES • SAN FRANCISCO • SPOKANE • SEATTLE

Chemical Engineering

JUNE 1954



MIXING

the Universal Operation

As a unit operation, mixing is noteworthy on two counts: it is both the most widespread, and the most empirical, of the unit operations. More than any other it seems to have resisted efforts to convert it from art to science. Old arts often tend to cling to their empiricism. Particularly is this the case with mixing, whose beginnings antedate recorded history. If we add to its antiquity—and the great backlog of experience in the hands of the adept—the fact that mixing is both many-faced and mathematically complex, it becomes easy to see why there is yet no over-all mathematical theory.

One consequence of mixing's early beginnings is that methods and equipment have tended to develop differently, even for similar purposes, in different industries. Hence equipment types have multiplied needlessly, adding to the problem of choosing the best type for a given case, making it more difficult for "natural selection" to shake out the less effective varieties. This over-specialization has also complicated the scientist's problem in his efforts to tie down the underpinnings of the art.

Realizing these problems, the editors nevertheless sought and obtained a manuscript worthy of joining the long parade of major unit operations reports which *Chemical Engineering* has brought each spring to its readers. To better mixing, and a better understanding of this universal operation, this 48 page special section is therefore dedicated.

THEODORE R. OLIVE
CALVIN S. CRONAN

MIXING
Liquids/Pastes/Plastics/

Every process industry uses mixing—most of them at several different points. But mixing is still very much of an art, based largely on accumulated experience. Here Author Quillen boils down a vast amount of that experience into six sections and 48 pages, to produce the most comprehensive mixing report yet presented.

Mixing is usually the most basic step in any processing sequence. It is one of the oldest of unit operations, with its roots in pre-historic cookery, brewing and pottery making. It occurs so commonly in its elementary forms on small quantities of material that there is a tendency to treat large-scale mixing operations indifferently. Then trouble may arise because the power requirements are underestimated, or because there is in fact no correlating similarity between the small laboratory batch and the large industrial batch. Differences in mixing liquids on the one hand, in contrast to the non-flowing plastics, or solids, on the other, may be a source of confusion.

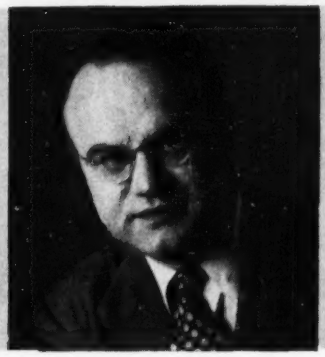
Where mixing originally was a hand operation, involving the hands literally, or simple tools such as spoon, paddle, shovel or hoe, the mechanization of industry has tended very largely to take mixing away from "end-users" like the housewife, pharmacist, or painter. Mixing has now become the function of the engineer or industrial compounder. Hence the engineer must now be able to select correctly, or design and provide adequate power for mixing machinery, suitable for a vast range of mixing operations.

Defining the Terms

As with many ordinary ideas, the terms used to describe various aspects of mixing are confusing and sometimes close to irrelevant. In general, the terms mixing and blending are interchangeable and are the basic terms. Some writers have used the term agitation to imply the mixing

Straight-blade radial-flow turbine-type mixers built from Inconel by Mixing Equipment Co. These are installed in 5,000-gal. Chloromycetin fermenters in Parke, Davis plant at Detroit. Note also sparger coil for sterile air agitation of the broth.

Solids/Continuous Mixing



Charles S. Quillen, consulting engineer of East Orange, N. J., and author of this report, has spent most of his professional life in activities having some connection with mixing. Within the next year he expects to develop this report into a full-length book, the first in English to deal at considerable length with this elusive subject.

Quillen's bachelor's degree in chemical engineering came from Drexel Institute in his native Philadelphia in 1933. Since then he has taken graduate work at several leading schools. His work has been in technical service, development, equipment sales, and in consulting. With memberships in American Institute of Chemical Engineers, American Chemical Society, and Franklin Institute, he still finds time to indulge his unusual hobby of printing and typography.

of liquids and light slurries. However, it seems better to confine "agitation" to the creation of a state of activity, motion, or turbulence, apart from any mixing accomplished; and to use the word "mixing" (or blending) when the idea of reaching a state of "mixedness" is meant. Of course, mixing can come about as a result of agitation, but there are other possible purposes in using agitation, for example, improving heat transfer.

Mixing, therefore, can be defined as the intermingling of two or more dissimilar portions of material, resulting in the attainment of a desired level of uniformity, either physical or chemical, in the final product. The theoretical idea of "complete uniformity" is an unattainable ideal in most cases. For example, when we mix particulate solids we find that only a random rather than an ordered arrangement of particles is possible.

A definition of the extent of mixing which will apply precisely in a general sense to all types of physical materials is impossible. The very nature of the particles involved makes for lack of precision. With homogeneous liquids and gases, particles are molecular in size and the mechanism of mixing is often chemical in nature. But, with plastics and solids, the particles are indeterminate. With them the degree of mixing can be determined only by sampling. With mixtures of plastic materials, or plastics with liquids or with solids, the degree of mixing can be established only by physical tests, if not by visual perception.

Under the broad term of mixing come certain specialized types, including kneading, mulling, dispersion, and emulsification. Kneading refers to the working of plastic masses and is a process of mixing by squashing, folding the flattened or thinned layers of material over one another, and then squashing again.

Mulling consists in a combination of rolling and smearing actions. Typically, it is accomplished by means of a wide-edged roll which travels in a circular path so that the face of the roll twists on its contact surface with the bed or bottom plate of the mixing machine. The material is rolled out into a layer which is then folded over upon itself by means of a plow before the roll passes over it again.

Kneading, rolling and mulling are used mainly on materials which are plastic in nature, such as very thick and stiff pastes, doughs, plastics, and rubber-like substances. These are also mixed by the shearing and tearing actions which occur as associated processes. Shearing in the body of a liquid can also be accomplished in mixers with close clearances between moving parts, such as between a blade edge and the vessel wall. For another example, a colloid mill utilizes close clearances between a rotor and stator ring to achieve shearing action.

The terms dispersion and emulsification generally refer to the mixing of colloidal substances. Dispersion is applied to the mixing of solids and liquids, or solids and solids, while emulsification means the dispersion of one immiscible liquid in another to form two distinct phases.

Uses of Mixing

Mixing of materials is used to achieve three general classes of desired results, as follows:

1. To produce uniformity of composition. This applies to the blending of liquids and pastes; to the mixing of particulate solids to produce uniform compositions, or to coat larger particles with powders; and to the mixing of particulate solids with plastics or liquids.

2. To promote chemical and physical reactions. In addition to a wide variety of chemical reactions, mixing

promotes such operations as dissolving, heat transfer, gas absorption, distillation, adsorption, and flocculation.

3. To change physical phase inter-relationships. This includes such operations as dispersion of immiscible liquids in each other for such purposes as extraction; emulsification of one liquid in another to form a quasi-homogeneous product; control of crystal growth in separation of a solid from a liquid and dispersion of gas as in froth flotation.

Valentine and MacLean (in Perry's "Chemical Engineers' Handbook") have given an excellent summary of the practical objectives of mixing. These authors also give tables useful for selecting mixers for various purposes.

In any of the various kinds of mixing operations mentioned we have not only to determine such basic questions as batch size, container volume, process conditions and mechanical features of equipment design, but also problems of the degree of agitation needed to accomplish a desired result, the length of time required for the operation, and the amount of power that must be supplied to give the desired degree of agitation.

The first step in considering any mixing problem, whether to select a suitable mixer, or to design one, is to examine and evaluate the physical properties of the ingredients, and of the mix, during the entire cycle of operation. The importance of this step cannot be overemphasized. A misunderstanding of these properties will generally result in an error, particularly when one is working with pastes or other high-viscosity materials. Only after the properties have been correctly evaluated, and the various stages of the process clearly understood, can the succeeding steps of choice of type and size of vessel and mixing device be taken.

The physical properties of the mixture ingredients have a dominant effect on the mixing operation, influencing the power required to perform the operation, the time to complete it, and the type of equipment to be used.

Mixing encompasses all possible combinations of gases, liquids and solids. So we are concerned with differences in phase. But beyond this are the important physical property differences between various fluids and solids. We must differentiate between liquids on the basis of density and viscosity. In solids we are interested in particle size, density, particle nature, and size distribution. Plastics fall in the borderland between liquids and solids. They are materials which will hold a boundary shape and yet have flow properties. Liquids may be considered to range from low to relatively high viscosity, with pastes in the still higher viscosity range. As we get into the higher viscosity area we find that some liquids and pastes possess abnormal flow properties which we call non-Newtonian.

At present there is no successful theoretical approach to the general subject of mixing. Although numerous investigators have attacked the problem along a number of paths, most of the theoretical treatment has been in the mixing and agitation of low-viscosity to medium-viscosity liquids. This is due in part to the fact that it is relatively easy to investigate liquid agitation. In addition, there is a background of analogous work on theory in the field of hydraulics and hydrodynamics which has been used to explain fluid agitation data.

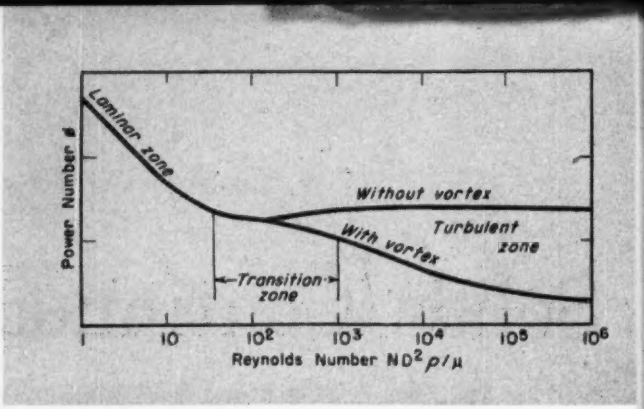


Fig. I-1—Typical Power-number plot for a mixing impeller. Like a friction factor curve it is plotted against a form of Reynolds number and shows laminar, transition and turbulent regions. The upper turbulent curve is the one produced when there is no vortex, presence of a vortex reducing the Power number (after Rushton).

Unfortunately, mixing of plastic materials, pastes, and particulate solids cannot be investigated from the hydrodynamic viewpoint. Consequently, development has been almost imperceptible here, even though such mixing operations constitute a large part of the subject. A few investigators have approached solids mixing from a statistical standpoint, but the writer is unaware of any theoretical work on the mixing of pastes or plastic materials.

The hydrodynamic approach has been useful in furnishing ideas and concepts descriptive of flow conditions and a basis for correlating test conditions and results. Dimensional analysis has been valuable in examining and differentiating between factors involved in different fluid flow regimes, and for correlating data. The concept of Power numbers plotted against Reynolds numbers has been useful in recording and predicting power requirements for a wide variety of impellers and agitation conditions.

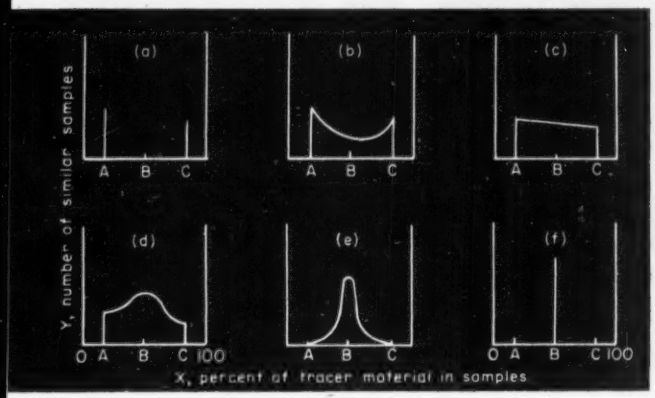
Theory for Fluids

In fluid mixing the intermingling of one substance with another is accomplished by diffusion and fluid motion. Fluid motion can be created by either natural or forced convection. The latter results in either additional mass motion to produce a major flow pattern; or in turbulence which can be considered as small-scale translations of matter. Momentum transfer from the moving stream to its surrounding envelope of more or less quiescent fluid causes entrainment.

These subjects of fluid motion, turbulence and momentum transfer, are customarily studied in fluid mechanics. It follows naturally that that is the branch of science used to describe the phenomena encountered in fluid mixing. We are interested in the inter-relationships between physical properties, velocity, force, momentum, dimensional boundaries, and distances of travel as they arise in connection with agitation of fluids in vessels.

The physical properties important in fluid mixing include viscosity and density of the fluids. Viscosity μ is that property which produces an internal shear stress τ in reaction to any force causing deformation of the fluid mass. Density ρ is the mass per unit volume. The ratio μ/ρ is called the kinematic viscosity ν. It is essential to note that viscosity and density are not only important

Fig. I-3—Redistribution sequence pattern in the mixing of two solids containing a common tracer ingredient (after Lofton et al). The first material contains A percent and the second C percent of the tracer as in curve (a) at zero time. As mixing progresses, in curves (b) through (d), the distribution of samples containing various percentages approaches the Gaussian distribution curve (e). The ideal situation of curve (f) is impossible.



Nomenclature

- A Area, sq. ft.
- D Impeller diameter, ft.
- F Force, lb.
- g_c Gravity conversion factor, 32.2 ft./sec.^{2}
- L Length or diameter, ft.
- N Impeller speed, rev./sec.
- P Power, ft.-lb./sec.
- V Velocity, ft./sec.
- v Distance traveled in unit time, ft.
- y Distance perpendicular to flow, ft.
- η Coefficient of rigidity.
- μ Coefficient of viscosity, lb./sec. ft.
- ρ Density, lb./ft.^{3}
- ν Kinematic viscosity, ft.^{2}/sec. $= \mu/\rho$
- τ Shear stress, lb. force/ft.^{2}
- ϕ Power number, dimensionless

separate properties, but important as they are related in the ratio μ/ρ.

Similarities between flow in mixing, and the more familiar flow in pipes, extend to the existence of both laminar and turbulent flow. Again, as in pipe flow, there is a characterizing criterion or Reynolds number which, although slightly different in form, is comparable to the pipe-flow Reynolds number. It is again the ratio between the inertial reaction per unit volume of liquid ($\rho V^2/L$) and the viscous force present per unit volume ($\mu V/L^2$), or

$$Re = (\rho V^2/L)/(\mu V/L^2) = VL\rho/\mu = VL/\nu$$

As in pipe flow the Reynolds number can be used to establish similarity between flow states in various types of containers. It should be noted that the larger the Reynolds number the less influence viscosity plays in determining the flow pattern.

The study of flow velocity in mixing systems can be extremely complex owing to the existence of instantaneous velocity variations, not only in the flow direction, but also in the other two directional planes normal to it. Von Kármán established that the three separate fluctuations are related quantitatively. It is interesting that Osborn Reynolds was probably the first to study these fluctuations.

The velocity of flow most easily determined is the average velocity. In turbulent flow, fluid masses are carried back and forth across flow planes whenever velocity fluctuations exist. When the transported mass adapts itself to the velocity conditions of the new surroundings, the resulting change in momentum will equal the product of the fluid density and the velocity of fluctuations. The force per unit area over which the momentum transfer takes place is equal to the stress caused by the momentum transport. Mass is transferred in any momentum transfer, and this basic movement of mass is the primary process of mixing. It is brought about by the secondary flow motion.

Power Consumption

In fluid agitation the major flow pattern (which causes the turbulence and entrainment, and results in mixing) is established by the mechanical action of an impeller, a jet or a stream of gas bubbles. The force equation relating the frictional resistance or "drag" of an impeller to its power consumption can be developed from Newton's law of momentum, which states that force is equal to the time rate of production of momentum. This follows from the consideration that the effect of an impeller blade moving in a fluid will produce momentum in the fluid. A rather simple analysis yields the equation

$$Pg_c = \phi\rho N^3 D^5$$

where ϕ is a function of the Reynolds number expressed as $ND^2\rho/\mu$. The group $Pg_c/N^3 D^5\rho$ is dimensionless and is termed the Power number. Many subsequent workers have followed White and his co-workers who in 1934 first related their data by plotting the Power number as ordinate against the modified Reynolds number given above. Fig. I-1 (after Rushton, *Chem. Eng. Progress*, **49**, 167, 1953) is an example of such a plot. It illustrates a type of curve which may be plotted for any impeller.

Principles of similitude may be used as a basis for scaling up agitation data from pilot plant to commercial production size equipment. Rushton has stated that when similar motion exists in two mixing tanks there will also be similar rates of chemical or physical actions. Although this may not be completely true for chemical reactions, the similarity concept does allow the systematic correlation of fluid properties, motions, sizes, and forces in mixing.

Theory for Solids

Solids and plastic materials have no inherent mobility of their own. The factor of diffusion is also missing. Hence they must be studied by other means than the fluid mechanics concept. A test of a suitable mixture is generally based on a sampling technique. Approaches to the theory for this type of mixing have generally been along lines of statistics and probability mathematics, but there have been very few workers in this field.

In any mixture of discreet solid particles a series of

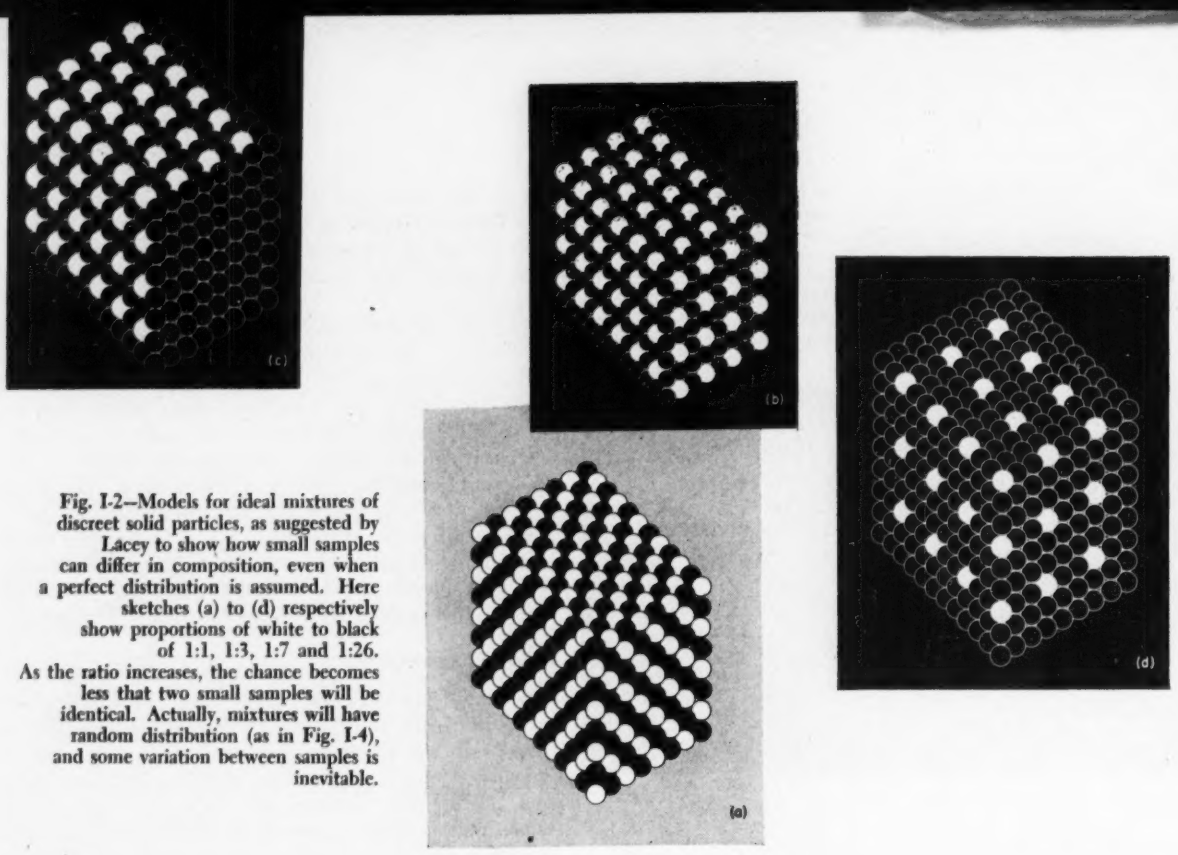


Fig. I-2—Models for ideal mixtures of discreet solid particles, as suggested by Lacey to show how small samples can differ in composition, even when a perfect distribution is assumed. Here sketches (a) to (d) respectively show proportions of white to black of 1:1, 1:3, 1:7 and 1:26. As the ratio increases, the chance becomes less that two small samples will be identical. Actually, mixtures will have random distribution (as in Fig. I-4), and some variation between samples is inevitable.

samples will be found to vary in composition around a mean value. The common idea that a perfect mixture of two components will produce identical samples, no matter how small, is an impossibility. Lacey (*Chemical Age*, 53, 119, 145, 1945) used the four models portrayed in Fig. I-2 to illustrate this situation. These models show ideal mixtures of uniformly sized white and black balls in the proportions of 1:1, 1:3, 1:7, and 1:26. It is evident that an extremely small sample taken from sketch (*d*) would be unlikely to demonstrate the correct proportion of white to black as being 1:26.

In these models the arrangements are completely ordered and uniform. Agitation of any of these models would cause it to lose its uniformity. This appears to be an inconsistency, since stirring and agitation are the very essence of mixing operations. So, it becomes clear that mixing actually creates disorder, rather than uniformity, allowing chance to determine the position of the particles. If we start with an ordered arrangement, such as the models, and then proceed to mix, the mixing introduces a certain amount of chance. Chance effects continually accumulate until they completely outweigh any direct effect of the mixer itself. Eventually, an equilibrium state is produced in which disorderliness is at a more or less stable maximum as, for example, in Fig. I-4. (Segregation may take place after a period of time, but this is a separate effect due to differences in size, weight or shape of the particles.) This equilibrium state is the maximum state of mixing that can be achieved by the mixer, and it is clearly the ideal toward which we should strive. Although the models of Fig. I-2 illustrate a theoretically ideal condition, this condition is valuable only as the end point in a mathematical analysis.

A knowledge of the exact arrangement which results when the particles are arranged in a random manner is never essential. It is important, however, to know how uniform a mixture will be from region to region within the material, or from sample to sample. This degree of uniformity can be defined by statistical methods, through the use of the concept of the standard deviation.

In carrying out any mixing operation, a great many different arrangements of the particles will occur between the initial segregated arrangement and the final random arrangement. There are various ways of showing this, for example, the plots of Fig. I-3. These show how the distribution of a common tracer ingredient which is present in each of two materials varies with time from the start to the finish of mixing. This method of diagramming was used by W. M. Lofton, Jr., and co-workers at the University of Louisville, in a report on a mixing study made to National Engineering Co.

To understand these diagrams consider that the first of the two materials mixed contains A percent, and the second material contains C percent of the tracer material. In the final mixture of the two materials the percentage of tracer will be *B*.

If the entire quantity of material is divided into a specified number of small equal samples, which are then analyzed for the tracer, diagram (*a*) will show the situation before mixing is started. All the samples will have a composition of either A or C, but there are more samples of the first material and hence a higher bar for A percent. At various times after mixing starts the entire mass

is again divided into small equal samples, analyzed, and the number of samples of various compositions is recorded, leading to diagrams (*b*) through (*d*). Eventually the situation of diagram (*e*) will be attained, which will be recognized as having the shape of a normal Gaussian distribution curve of deviation vs. frequency. As we have noted, the ideal situation of diagram (*f*), where all samples would have the composition of *B*, cannot be reached by our mixing device, but can only be approached as a limit.

The curves thus represent at any given time the probability of there being samples of a given composition in the mix, the ordinates representing probability coefficients.

If there are differences in density, electrical charge or particle size in materials being mixed, the mixture may not attain a true random arrangement, no matter how long it is agitated. In such cases the arrangement will generally be composed of regions of segregation dispersed throughout the material. In any event, however, to improve the mixing of solids it is advisable in most cases to decrease particle size. The improvement which can be made in this way can be measured quantitatively by statistical methods.

Mixing Time

In most mixing researches the question of mixing rate or time required for mixing has not been studied. This factor has generally been treated in a general sense only, evidently on the assumption that if means is provided for turbulence in fluids, or thorough volumetric interchange in non-fluid materials, then completion of optimum mixedness will occur as a matter of course. One of the few mathematical studies of mixing time was that made by Brothman, Wollman and Feldman (*Chem. Met. Eng.*, 52, 102, April 1945). This treatment regarded mixing as a three-dimensional shuffling operation and considered it

Table I — Range of Operation of Mixers

Key — Black line = batch process
Colored line = continuous process

Mixing Device	Report Section No.	Viscosity, Centipoises 10^2	10^3	10^4	10^5	Plastic state	Solid state
Air agitation	2						
Liquid jets	2						
Paddles	2, 3						
Propellers	2, 3						
Turbines	2, 3						
Cones	2						
Disks	2, 3						
Screws	3, 4, 5						
Barrels	3, 5						
Ball mills	3						
Ribbons	3, 5						
Kneaders	4						
Colloid mills	3						
Special mills	3						
Mullers	4, 5						
Pug mills	4, 5						
Internal mixers	4						
Roll mills	3, 4						
Conical mills	5						
Pan mills	5						
Impact wheels	5						

from the standpoint of probability. However, the treatment covered only an ideal case and did not deal with the equilibrium condition of mixedness which we have just been discussing. An important conclusion from this study is that if the properties of the components of one mixture are reasonably close to those of another, then the same type of mixing device can be expected to give, roughly, similar performance and similar time, provided the same degree of mixedness is required.

Materials Properties

As we noted earlier, the first step in the evaluation of any mixing problem is to consider the physical properties of the substances to be mixed and the effect these properties will have upon the operation itself, the power consumed, and the time required for completion of mixing. The flow properties of the material are those that will be considered first. And, as their effect becomes apparent, other properties which influence the mixing operation may be considered. These include specific gravity, ease of wetting, surface tension, particle size and shape, solubility, and electric charge.

The problem of terminology and precise definition is nowhere more perplexing than it is in rheology, the science of flow. As an example of terminology difficulties, E. K. Fischer in his book on colloidal dispersions points out that a solid-liquid dispersion can lead to such descriptions as stringy or "long" like molasses; or fluid and perhaps as limpid as water. On the other hand, a composition may be a stiff paste such as painter's putty or a soft paste such as mayonnaise or whipped cream. In some cases an impression of "tackiness" is obtained by tapping a film of the composition between the forefinger and a smooth surface. Such visual and tactile impressions describe flow properties too complex for simple mathematical description.

There are also other inferences often attached—for example, it is fairly common practice to note that the solid dispersed in a freely flowing composition is "well wetted," whereas that in a non-fluid paste is "poorly wetted."

Viscosity, Real and Apparent

When we consider the flowing quality of a liquid we first consider its property of viscosity. The basic law of viscosity was first stated by Newton who considered the flow of a liquid over a solid bounding surface as characterized by a gradient of velocity. He noted that the fluid at the boundary was stationary, while adjacent layers or regions increased in velocity as the distance increased.

However, not until the nineteenth century did physicists turn to the experimental measure and definition of viscosity. Poiseuille, about 1820, made a thorough study of the flow of fluid in capillaries, which led directly to the laws of viscous flow. Hagan confirmed his results and later investigators supplied various correction factors along with a theoretical analysis of flow and the definition of the coefficient of viscosity. This coefficient is usually called viscosity, that is, the same word is used both for the general property and for the numerical measure of it.

Viscosity is the tendency of a true fluid to resist continuously any motion which produces internal shear. Imagine a pair of plates separated by a liquid film as in Fig. I-5. The plates are assumed to be so large that the conditions of their edges can be neglected. If a force F is applied tangentially to the top plate, moving it with a velocity V, then the angular displacement of line ab is v/y, or F is proportional to v/y. For a unit area, where the area of the upper plate is A, and assigning the character μ to the constant of proportionality, we have $F/A = \mu\ (v/y)$. Letting τ equal the force per unit area and using the differential form to recognize that velocity distribution may not be entirely uniform between the stationary and the moving plate, we have the equation $\tau = \mu\ (dv/dy)$. This expression gives the relation between the shear stress τ and the rate of angular deformation dv/dy for one-dimensional flow of a fluid. If the shear stress τ is plotted against the rate of shear dv/dy, we obtain a curve which characterizes the relation between shear stress and rate of shear, showing whether the fluid is Newtonian or non-Newtonian.

Fig. I-4—Actual mixing machines produce a random arrangement in mixing of particulate solids, as this grouping of 200 white and 200 black squares suggests. Fig. I-5—Parallel planes, bounding layers of liquid, help to visualize the concept of dynamic viscosity. Fig. I-8—Concentric-cylinder viscometer principle is similar to ideal system expressed in Fig. I-5.

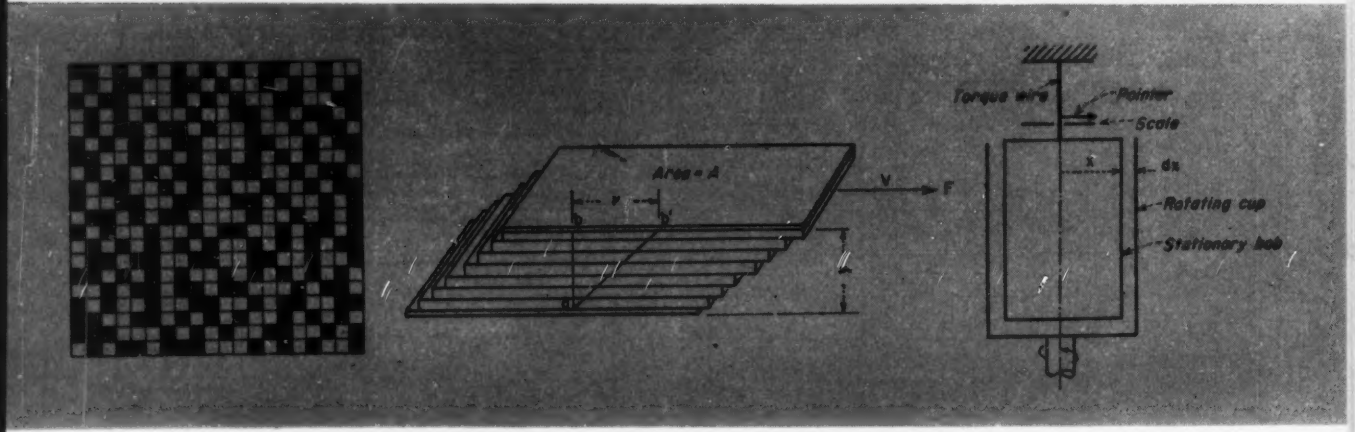


Fig. I-6 shows that in the case of Newtonian fluids the relationship between shear stress and rate of shear is a straight line starting at the origin. Plotted on the same chart are a number of other curves of types produced by non-Newtonian liquids. Although we cannot properly speak of "viscosity" with the non-Newtonian liquids, the term "apparent viscosity" (or sometimes "consistency") has long been used by analogy to the Newtonian viscosity and can be used without too much danger of confusion if it is recognized that apparent viscosity is a factor which may vary either with time or with rate of shear, depending on the type of non-Newtonian liquid.

Newtonian liquids flow when acted upon by any force, however small, and their rate of shear is directly proportional to the shearing stress as the straight line in the figure shows. The slope of this line is the coefficient of viscosity μ. Fluids having Newtonian flow properties are sometimes referred to as true fluids. They include gases, pure liquids of low molecular weight, or true solutions of low-molecular-weight solutes in a liquid. They include also other solutions if sufficiently dilute. Examples include gasoline, glycerin, solutions of inorganic salts and acids, etc.

Non-Newtonian fluids can be grouped into two general classifications: (1) Those whose properties are not time-dependent; and (2) those having time-dependent properties. In addition to the Newtonian liquid curve, Fig. I-6 shows curves for three types of non-Newtonian liquids which are not time-dependent.

In the first of these, the so-called plastics or Bingham plastics, no movement takes place until the shearing force exceeds a certain yield strength τ_y, after which a straight-line relationship between shearing force and rate of shear ensues. The slope of the line is now termed the coefficient of rigidity η and the intercept on the τ-axis is called the yield strength.

Plastics are evidently substances which have some inherent interlocking structure which can resist forces less than the yield strength. When the force exceeds the yield strength, however, the resistance disappears. Plastic fluids in general are suspensions of approximately equi-dimensional solids in a liquid, for example, drilling muds, coal, ores and sand in water.

Also non-Newtonian and not time-dependent, are the pseudoplastics which are substances having no rigid interlocking inner structure. They appear to consist of particles or molecules which become progressively more aligned in the direction of flow as the shear stress increases. The effect is that as the rate of shear increases, a progressively smaller increase in shearing stress is necessary. One would expect that solutions or suspensions of long thin particles or molecules would produce such behavior, for example, solutions of organic polymers, certain slurries of paper pulp, soap, and detergents.

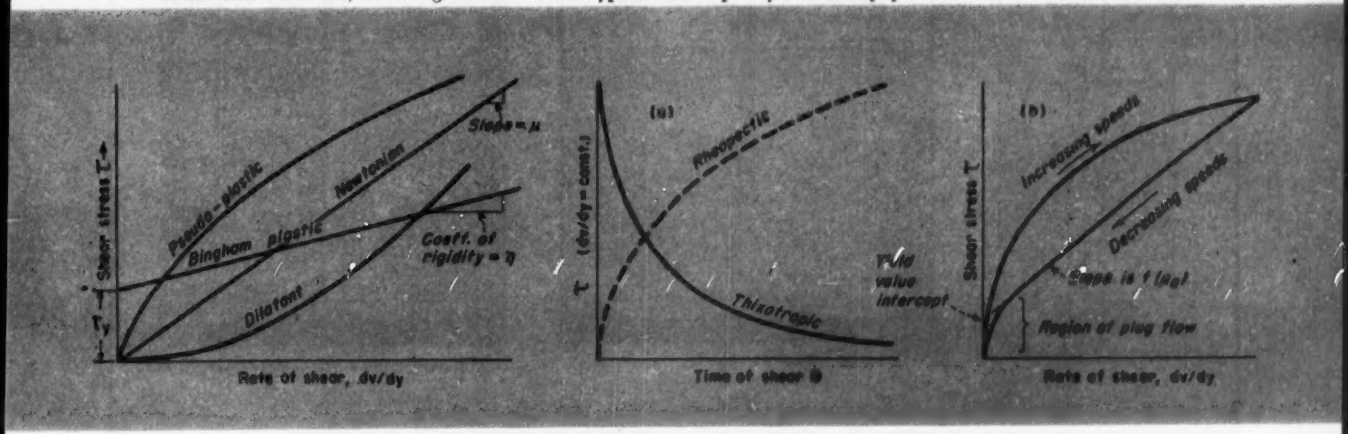
The third non-time-dependent non-Newtonian type is called dilatant. In the case of dilatant fluids the effect is opposite to that of the pseudoplastics in that the apparent viscosity increases more than rate of shear. The hypothetical explanation would be that the molecules are in the shape of tightly balled springs which become opened and drag by intermeshing with adjacent molecules once sufficient stress is applied. Dilatant fluids include uncooked starch slurries, deflocculated pigment dispersions with high proportions of suspended solids, mica suspensions in water, and suspensions of quartz powder in water with particles in the 1-5 micron size range.

Time-Dependent Properties

Two classes of fluids have flow properties which depend on the duration of the shear. The first of these, thixotropic fluids, basically resemble the pseudoplastics in having a random arrangement of molecules in the condition of rest which, however, form an internal structure. This structure is broken down under shear, but the degree of particle alignment that may occur in the direction of flow depends on the time of shear as well as on its rate. In Fig. I-7a the shear stress is plotted against the time of shear with the rate of shear dv/dy held constant. With thixotropic

(Continued on p. 224)

Fig. I-6—Diagram illustrates difference in flow characteristics between Newtonian liquids, and non-Newtonian liquids such as pseudoplastics and Bingham plastics. Fig. I-7a shows how thixotropic and rheopectic liquids vary their shear stress with time, while Fig. I-7b shows the typical thixotropic hysteresis loop produced as shear rate is altered.



Liquid Mixing

In many chemical processes the lead-off step is the mixing or agitation of low-viscosity liquids.

Mixing becomes more difficult as batch size increases. Volumes less than 50 gal. are mixed easily under normal conditions. Unfortunately, process applications nearly always are larger than 50 gal.; batches as large as 4,200,000 gal. have been mixed successfully.

To be successful, mixers for low-viscosity liquids in quantities over 50 gal. must be essentially fluid-displacement devices. In this respect they are similar to pump impellers. They extend the action of the agitator by increasing fluid flow to all zones in the vessel.

Intermingling and transfer of liquid throughout the vessel can be done by jet impellers with high liquid displacements, or by recirculating devices.

As a point of reference, the author considers 2,000 centipoises the demarcation line between low-viscosity liquids and more viscous materials. Of course, higher viscosity liquids can be handled by various types of agitators. However, batch volume becomes increasingly important as higher viscosities suppress flow velocities and turbulence.

Air Agitation

Air or other gases can be bubbled or blasted through a liquid to create turbulence. Preferably, air is used when needed for chemical reaction or as an aid for mechanical mixing to reduce power requirements. Also it is used with paddle agitation to help create currents initially started by paddle action. Air-lift agitators employing this method are shown in Fig. II-1.

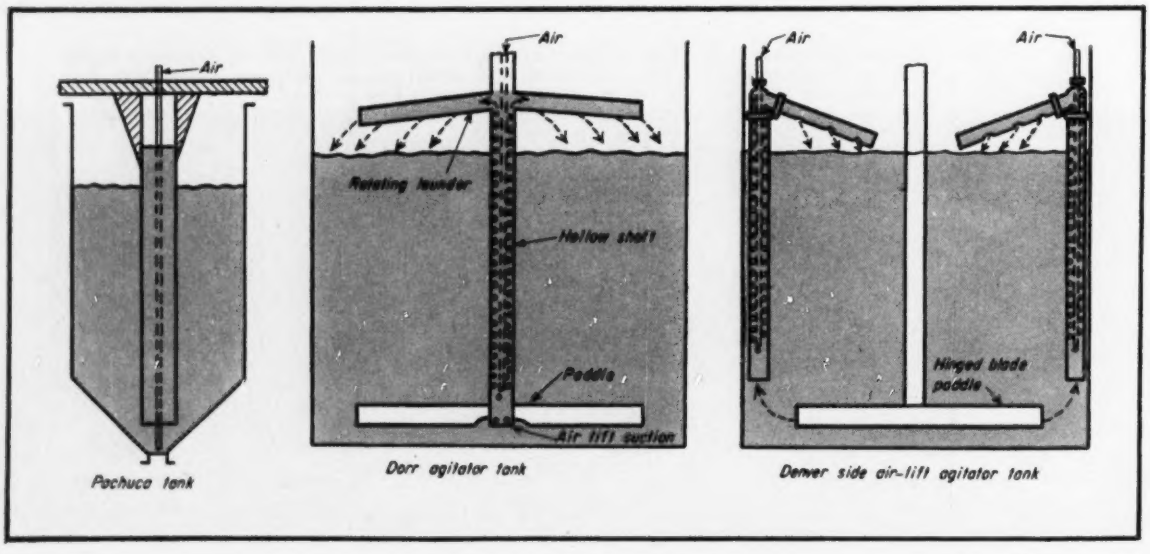
Sometimes air agitation is used simply because there happens to be excess compressor capacity. Or it may be that the initial piping installation appears cheaper than the purchase of a mechanical mixer with accessory electric wiring and controls. Basically, however, air agitation is inefficient; it does not compare favorably with electric-motor-driven mixers. Yet, despite this inefficiency, it fills a real need in applications such as corrosive liquid jobs, fluidizing high-percent-solids slurries, or agitating very shallow vessels where mechanical mixing is impractical.

Mixing action by a stream of bubbles is haphazard. Released from a nozzle at the bottom of a vessel the bubbles take a direct vertical route to the surface of the liquid. Very little side-to-side displacement takes place. By contrast, air blasts can be directed. They behave like jets and improve mixing action by entrainment. Degree of agitation depends on the process and the liquid under consideration, as well as on the quantity of air flowing and the velocity of air leaving the orifice.

Better agitation is obtained with deep tanks than with shallow ones. This is due to expansion of the gas bubbles as they rise in the liquid. The quantity of air discharged under water is the same as the quantity that would discharge from orifices into the atmosphere under a pressure equal to the pipe pressure, less hydrostatic pressure due to depth of water above the pipe.

In discussing air needed to produce various degrees of agitation Kauffman (*Chem. Met. Eng.* **37**, 178-180, March, 1930) recommends the following quantities of air per square foot of tank cross sectional area for a liquid depth of 9 ft.:

Fig. II-1—On the left a pachuca tank where air-induced circulation through a central riser produces a mixing action. In the center, a Dorr agitator tank teams an air lift with a paddle agitator to improve turnover and intermingling of tank contents. On the right, a Denver agitator tank uses a side air lift to help paddle action.



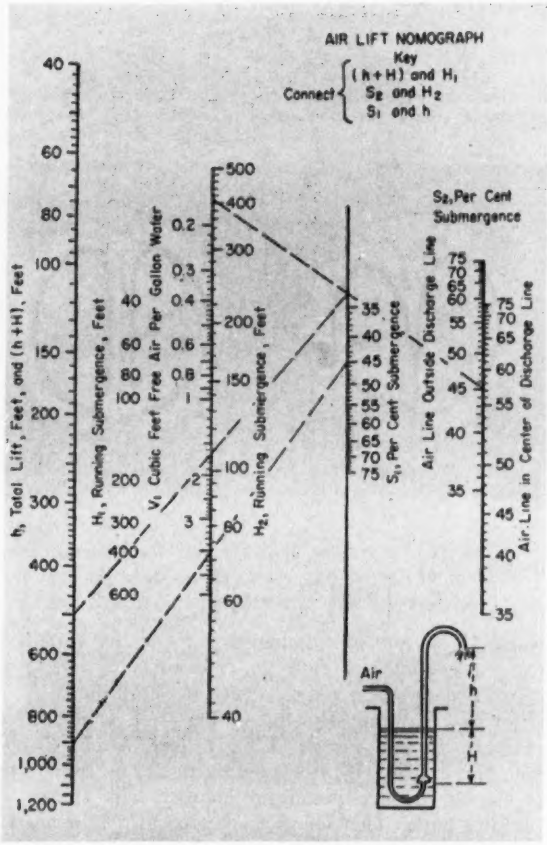


Fig. II-2a—Volume of free air at standard conditions needed to raise 1 gal. of water through a given distance is found on this chart when water depth above inlet is known.

Moderate agitation.....0.65 cu. ft. free air/min.
Complete agitation.....1.3 cu. ft. free air/min.
Violent agitation.....3.1 cu. ft. free air/min.

If liquid depth is decreased to 3 ft. air consumption must be doubled to provide the same degree of agitation.

Air pressure needed to produce agitation is the sum of three factors: the liquid head in the vessel; the frictional resistance to air flow in the piping; and the pressure difference required to force air through orifices or nozzles.

How much air will flow through a given size pipe can be calculated from the expression:

$$Q = 60\pi D^2 V/(4 \times 144) = 0.327 D^2 V$$

where Q = quantity of air flowing, in cfm.; V = velocity in fps.; and D = pipe diameter, inches.

Volume of air flow through any orifice form of known diameter, under any pressure less than 10 psi., is shown in Fig. II—2b which is based on the formula

$$Q = 21.7 D^2 C H^{1/2}$$

Here H = head or pressure as inches of water column; C = a constant depending on the kind of orifice; and Q and D are as above.

Different values of C were suggested by Kauffman. Here we can use 0.6 for an orifice made by drilling a hole in a pipe.

When air lifts are used as shown in Fig. II-1 it is necessary to calculate the volume of free air at standard temperature and pressure required to raise 1 gal. of water through a certain distance when the depth of water above the air inlet is known.

An alignment chart, Fig. II-2a, developed by D. S. Davis (*Chem. Met. Eng.*, **39**, 101, Feb. 1932) is based on the following equations:

$$S = 100\,H/(h + H)$$
$$V = h/C\log[(H + 34)/34]$$

where h = total lift in ft. or distance from the surface of the water to the discharge outlet; H = the running submergence in ft. or the depth of water above the air inlet; C = air lift constant from the following table, depending upon the percentage submergence and position of the air inlet pipe; S = the percent submergence; V = the volume of free air in cu. ft. required for 1 gal. of water.

Table I. Values of Air-Lift Constant

	Values of C*	
S	Air Line Outside Discharge Pipe	Air Line Inside Discharge Pipe
35	216	162
37	—	171
40	246	185
45	272	204
50	296	228
55	318	262
60	335	285
65	348	306
70	358	322
75	366	330

* Ingersoll-Rand Air Lift Catalog No. 77, p. 15

Gas-Liquid Mixing

The simple addition of gas through jet, diffusion valve, porous plate, or sparger pipes is sometimes used without mechanical agitation to perform gas absorption or stripping operations. Under these conditions best results are achieved with tall tanks to provide the maximum gas pass. More frequently a mechanical agitator is used to achieve maximum efficiency by dispersing the gas particles, scrubbing the gas-liquid interface to increase the rate of transfer and by multiplying the length of travel of the gas particles.

These devices are special variations of turbines, altered to provide maximum gas handling capacity. Another specific design for these applications is the Turbo-Gas absorber consisting of special design of turbine impeller rotating inside a stationary deflecting-blade ring with down-flow hooded cover. Several variations of the vaned disk, consisting of horizontal blade with straight blades on the under side or on bottom and top side extending beyond the straight periphery, are in common use. Multiple propellers on a vertical shaft are sometimes used in vegetable oil hydrogenation.

The well-known flotation-machine designs have been applied to gas absorbers, but are less efficient. The me-

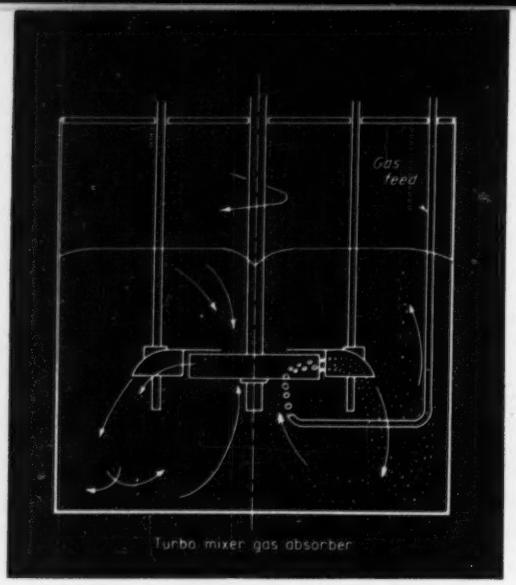
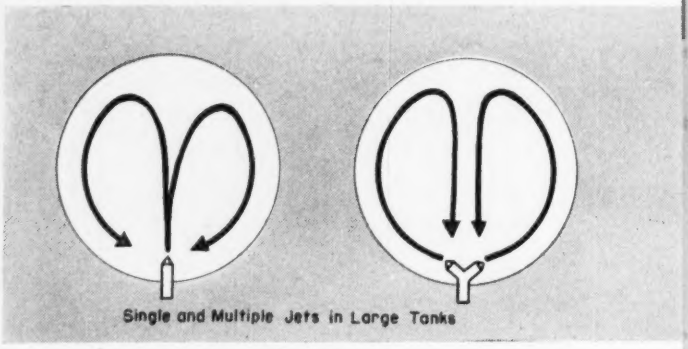


Fig. II-3—Improved absorption efficiency of gases in liquids is the purpose of this turbine-deflecting-ring combination. (Turbo-Mixer Div., General American)



chanical absorbers have been applied successfully to all of the common gas-liquid operations and individual units can handle upwards of 3,000 cfm. of gas. (This discussion of gas-liquid mixing was contributed by Emerson J. Lyons, Manager, Turbo-Mixer Div., General American Transportation Corp.)

Jet Agitation

High-velocity jets of steam, air or gases and liquids possess certain advantages for mixing low-viscosity liquids. Factors influencing selection may stem from corrosion problems, type of vessel or cycle of operation.

Jet agitation is applied either by use of a nozzle for direct injection of a free jet of liquid or gas; or by using an inductor to the tank or eductor in the body of the liquid.

A free-jet stream is similar to the stream from a propeller except for the absence of the multiple helical layer generated by separate propeller blades. It has the same ability to capture by entrainment from the surrounding liquid envelope as the stream travels away from the jet nozzle. Entrainment takes place according to a definite pattern and in a definite proportion. The jet stream enlarges cone-wise until the velocity either dissipates or the flow feeds back into the jet stream as directed by the geometry of the vessel.

As a mixer the jet works mainly by entrainment. This is caused by the transfer of some of the momentum from the high-velocity jet stream to the surrounding envelope of slowly moving or stagnant liquid. The situation is illustrated by the schematic drawing in Fig. II-5 which shows the cross section of the jet stream in a surrounding liquid. The central axis of the stream is taken as the x-axis. Jets of water flowing into water entrain the surrounding water (Folsom and Ferguson, *Trans.* **A.S.M.E., 71,** 73, 1949) in accordance with the following equation derived for such condiitons:

$$Q_e = \left[0.23\left(\frac{x}{d} - 1\right)\right]Q_0$$

where Q_e = rate of entrainment, or quantity entrained; Q_0 = rate of flow at entrance, or quantity flowing; x = distance along x-axis; and d = entrance jet diameter.

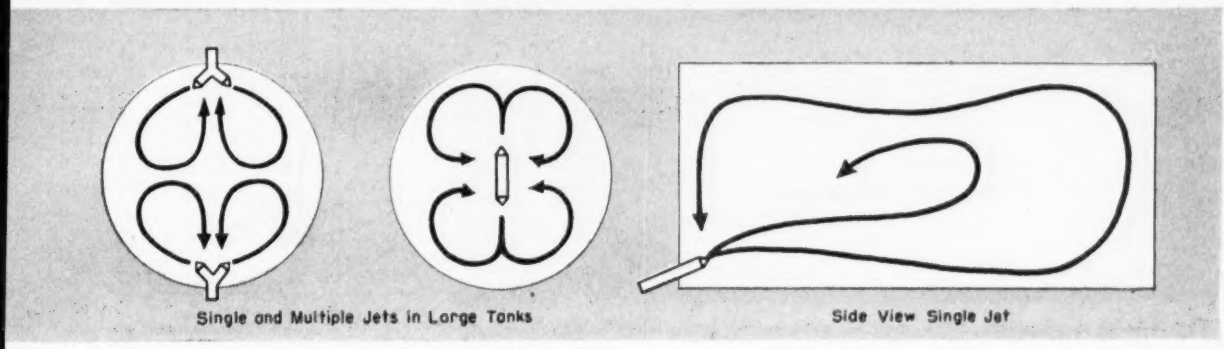
Jet flow patterns depicted in Fig. II-4 were charted (Fossett, H. and Prosser, L.E., *J. Inst. Mech. Engrs.*, **160,** No. 2, 224, 245, 1949) during studies on the mixing of liquids in large petroleum industry bulk storage or blending tanks. They found it necessary to tilt the nozzles upward to distribute the incoming dense liquid more uniformly throughout the volume of the tank and so prevent stratification into layers.

Injectors mix one liquid stream into another in a pipeline; eductors perform mixing inside tanks. They transfer momentum from a high velocity fluid to a low velocity fluid and at the same time mix the two fluids thoroughly. The injector nozzle converts potential energy in the drive fluid to kinetic energy. The resulting high speed jet entrains the slow-speed liquid.

Sizing of injectors and eductors for given mixing jobs rests on treating them as jet pumps. The groundwork for such analyses was established by R. G. Folsom (*Chem. Eng. Progress,* **44,** 765, 1948) and M. P. O'Brien and J. E. Gosline (Univ. Calif. Pub. **3,** 3, 167-190, 1934). O'Brien and Gosline established $H = (1 - N)/(N + M)$ as the head-capacity curve for all liquid self-entrainment pumps. The factor N is a function of loss coefficients, K, in the pump drive line, the suction line, the discharge line, and skin friction loss in the mixing tube as well as the ratio of capacities, $M = Q_s/Q_j$, in the suction and drive lines and the ratio of cross sectional areas in the drive and mixing tubes, A_j/A_t.

Loss coefficients must be measured or estimated for any specific pump, injector or eductor. Knowing these and the geometric proportions of the device, the head-capacity and efficiency performance characteristics can be predicted

Fig. II-4—Flow patterns for liquid jets are based on studies of mixing in large petroleum industry bulk storage or blending tanks. Investigators found it necessary to tilt nozzles upward to distribute properly the incoming dense liquid and, thereby prevent stratification of the liquids into layers.



from calculations. Based either on calculation or tests, plots can be made of M vs. H and M vs. MH. Only a half dozen points are needed over the operating range to establish good curves.

To enhance the usefulness of information from such curves the characteristics can be represented on a $Q_s - Q_j$ coordinate system, Fig. II-7. η_j = the efficiency and n is head at measuring points denoted by subscripts d for pump discharge, 1 for pump drive, 2 for pump suction. For a particular system, the pertinent elevations, pressures, capacities and losses will establish h_s, h_d and Q_s. When placed on the chart, the intersection with the proper curve will show Q_j and h_j to operate the unit.

Paddle Mixers

The rotating paddle mixer holds a fundamental position in mixing technology by reason of its simple construction. In form and design the simple paddle may appear in a considerable range of variations. For the most part, however, it is made as a single horizontal beam attached at its midpoint to the lower end of a vertical rotating shaft.

In the vertical cylindrical type of vessel generally used in chemical plants, the paddle shaft is located on the vertical axis. The single paddle then operates in the lower part of the liquid volume. It can be placed just above the bottom or from 3 to 10 in. above, depending on the agitation conditions.

Frequently shorter paddles are used as secondary members to supplement the mixing action. These may vary from one-half to the same length as the primary member. In the case of a vessel of circular cross-section, length

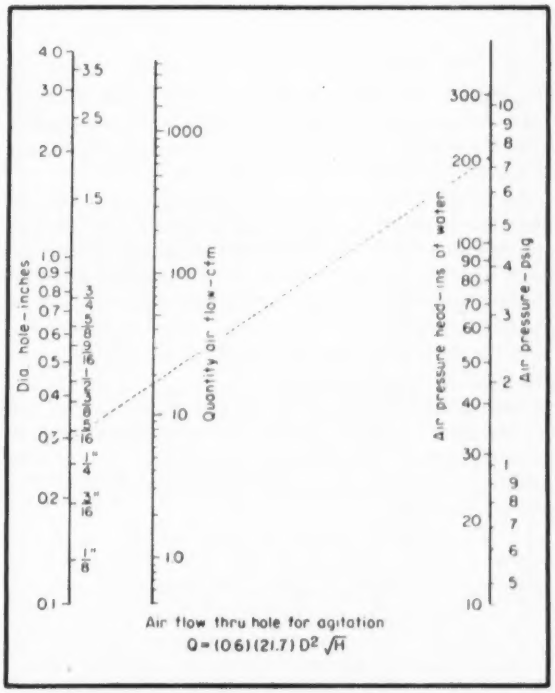

Dia. hole - inches
Quantity air flow - cfm
Air pressure head - ins of water
Air pressure - psig
Air flow thru hole for agitation
Q = (0.6)(21.7) D² √H

Fig. II-2b—How much air will flow under any pressure less than 10 psi. through an orifice drilled in a pipe can be found on this nomograph where a value of 0.6 = C.

Table II—Common Dimensions for Simple Paddles

Paddle Dia., In.	Blade Width, In.	Blade Thickness, In.	Ratio, (W/D)
15	2	¾	0.133
21	2½	½	0.119
27	2½	½	0.0926
33	3	½	0.0909
36	4	½	0.111
42	4	½	0.0953
48	5	¾	0.104
54	5	¾	0.0926
60	6	¾	0.100
72	6	¾	0.0834
84	7	¾	0.0833
96	7	¾	0.0729
108	8	¾	0.0742
120	8	¾	0.0667

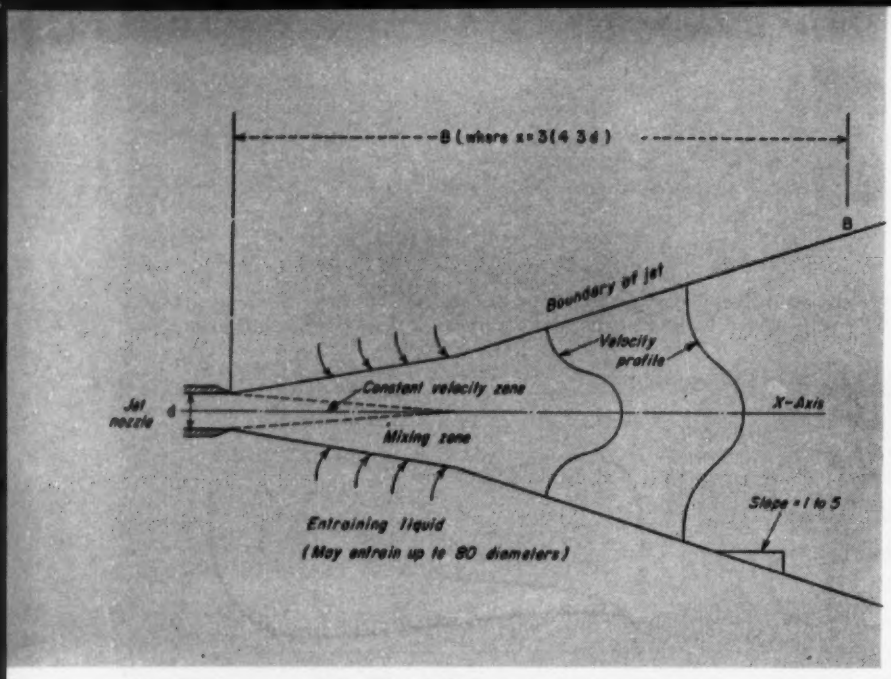


Fig. II-5—Jet stream cross section indicates entrainment action when a high speed jet is injected into a slowly moving or stagnant liquid. Note how cone-wise enlargement dissipates the entering velocity.

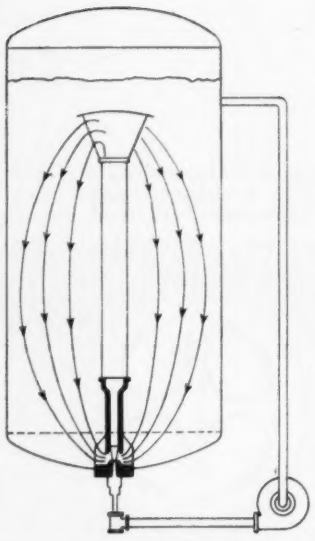


Fig. II-6—Eductor uses kinetic energy of entering stream to mix batch. (Schutte & Koerting)

of paddle varies from slightly less than the diameter down to one-third the diameter. Most common practice is to use paddles with lengths approximately 80 percent of the tank diameter.

Paddle width varies widely in proportion to length. In American practice, paddles generally have width-to-length proportions of 1 to 10; variations from this proportion range all the way up to 3 to 1. Dimensions given in Table II generally are adhered to by the author for simple paddles constructed of steel or other alloys. Use of wood calls for increasing the paddle thickness to allow for decreased structural strength.

Among mixers the paddle is one impeller that can be operated to cause a minimum of displacement or pumping action. It frequently is used for viscous flow conditions. When the speed of rotation increases flow becomes turbulent.

In an unbaffled cylindrical vessel, paddle movement imparts a swirling motion to the liquid. There is some displacement of liquid due to centrifugal force although it is not appreciable. At equilibrium the rotational speed of the swirling liquid approaches that of the paddle. This means poor mixing because turbulence is missing. Therefore, effective paddle mixing in a cylindrical vessel depends on the use of baffles. In effect, these are stationary paddles that work with the moving paddle so to maintain a satisfactory degree of turbulence needed for mixing.

Larger liquid volumes call for additional blades or paddles on the agitator shaft so that all zones within the vessel will be mixed. Frequently, a tank's diameter may be greater than its depth, so that paddles may be needed on more than one shaft. As liquid depth increases, additional paddles can be installed on the upper part of the agitator shaft. These are spaced symmetrically according to the vertical cross-sectional proportions of the vessel.

During withdrawal of liquid from tanks the paddle mixer has a definite advantage over other agitator types. The liquid heel in the tank bottom can be kept thoroughly agitated. Propellers and turbines under similar conditions vortex and suck air, with the likelihood that severe vibration will occur.

Speed of rotation dominates the proper use of a paddle. There is a limiting maximum speed for any given viscosity or consistency. In general, paddle speed need be sufficient only to produce turbulence throughout the entire liquid volume. This represents the point of minimum power absorption for adequate mixing. From this standpoint it has been customary to use rotational speeds that give peripheral velocities at the blade tips in a range from 300 to 400 fpm. It is interesting to note that such peripheral velocities produce very high Reynolds numbers in water. As the viscosity increases, *Re* decreases rapidly.

Under low viscosity conditions Fig. II-14a, which applies to turbulent flow when *Re* is greater than 300, can be used to determine power required for single simple paddles.

As liquid viscosity increases it becomes necessary to undertake changes to insure agitation throughout the entire volume of liquid. Either the number of paddles must be increased, or they must be modified. Numerous combinations of multiple paddles are possible. Before selecting a combination several points should be considered.

The chime or corner between the wall and bottom of the vessel is generally the most difficult part to reach. Frequently, the lowest paddle is shaped to conform to the contour of this corner. Supplementary paddles are spaced on the shaft according to the designer's opinion of the length of the liquid flow path. His opinion may be based on laboratory tests of the liquid flow characteristics.

As fluid viscosity decreases, fewer paddles are needed. Increasing viscosity that approaches paste consistency may

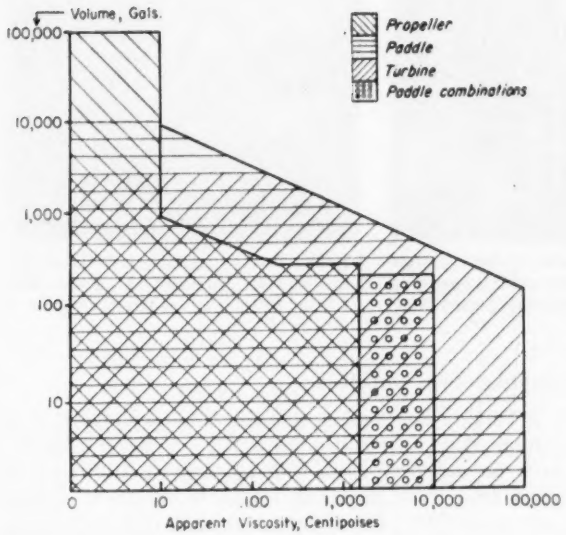


Fig. II-8—Each impeller mixer has its own practical operating range for various combinations of batch volume and apparent viscosity. Chart shows overlap relationship.

indicate need for breaker baffles. These can be affixed to a baffle cage or fastened directly to the vessel wall to break up centrifugal flow created by the moving paddle. At times supplementary paddles are rotated in a direction opposite to the main paddle rotation. Such a double motion drive is used frequently in grease kettles.

Among paddle combinations, Fig. II-9 shows horizontal paddle combinations, reels, vertical finger paddles, gates, anchors, double-motion horizontal paddles with breaker bars, and double-motion paddles with gates. Some of these are used not only on low- but also on high-viscosity liquids.

Propeller Mixers

Propeller mixers are simple in construction and low in cost. Furnished complete with driver, they are used extensively within viscosity limitations for blending liquids, transferring heat, dissolving solids and reacting materials. Because of their low initial cost, they are used sometimes where other types of impellers might be more efficient for mixing of immiscible liquids, for solids suspension and for gas absorption.

The propeller is essentially a high-rotative-speed impeller; it operates best in low viscosity liquids. It has a high rate of displacement that quickly recirculates the liquid volume. Mixing occurs in the propeller zone and between the various currents generated throughout the liquid volume.

An outstanding application is the use of propellers for mixing very large volumes of low viscosity liquids. Typical of this is gasoline blending where tank sizes run up to 4,200,000 gal.

In large-volume mixing, propellers produce a large-diameter stream which behaves essentially like a jet. Momentum imparted by the propeller pushes this stream into regions of liquid having little motion.

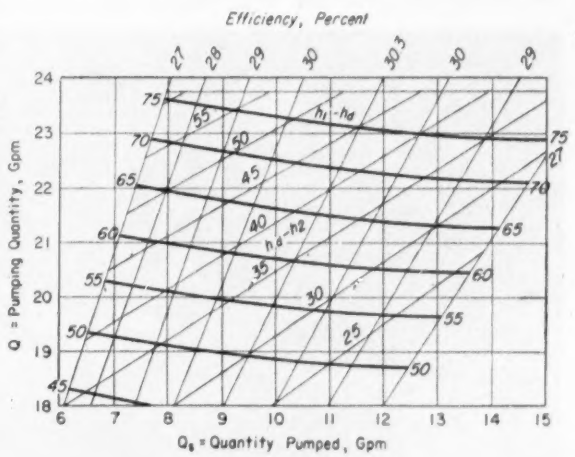
The type of liquid flow pattern created by the propeller is shown in Fig. II-11. When mounted over a container in a vertical position the propeller may form a vortex unless the liquid depth exceeds a critical amount. This condition will exist if the propeller axis is near the central axis of the vessel and there is no baffling. The tendency to vortex can be prevented by installing the unit in an off-center position. Portable units are built with swivel mounts for this purpose.

In operation a propeller sucks in liquid directly behind it, as well as from the region surrounding its circle of operation, unless flow is directed by means of a draft tube. Inflow velocity to the propeller is lower than efflux velocity, although the difference is reduced when a draft tube is used. Liquid leaves the propeller in the form of a moving cylinder made of three laminar helices of differing velocities. Flow velocity of the entire cylinder is proportional to the rotational speed. How much liquid is displaced is directly proportional to propeller speed and the square of the propeller diameter.

High turbulence is created by eddy currents between the interfaces of the three helical waves of streams from the separate blades; also between the core of liquid in the propeller stream and the surrounding liquid. It is believed a propeller stream entrains surrounding liquid at a higher rate than a jet stream does. This can be attributed to turbulence in the envelope layer of the moving propeller stream.

A stream from a propeller can be directed anywhere inside the vessel, either to increase turbulence by impingement on baffles, to provide the easiest return flow to the propeller, or to reach zones beyond the standard flow pattern.

Fig. II-7—Performance curves for water-jet pump. The drive line has a diameter of 1¼ in. and the discharge line 1½ in. Symbols on the curves designate the following factors: h_1 = pump drive pressure, ft. of water; h_4 = pump discharge pressure; h_2 = pump suction pressure; Q = quantity of water used for drive; Q_s = quantity of water in suction. Jet area/area of outlet tube = 0.43.



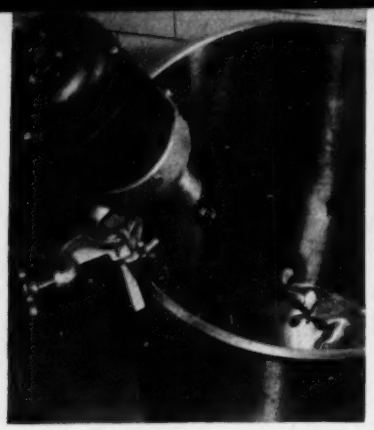


Fig. II-12a—Direct-drive portable mixer can be swung on mount either to avoid or create vortex. (Mixing Equipment Co.)

Fig. II-12b—Giant turbine is 5 ft. in dia., has neoprene covering on curved non-pitched blades. (Turbo-Mixer Div.)

At times two propellers of opposite pitch are mounted on the same shaft in what is called a push-pull arrangement. The resulting intermediate turbulent zone is more violent than exists in the zone of either impeller individually.

The regular three-bladed marine propeller is standard for low-viscosity mixing. Further, the industry has standardized on the "square pitch" propeller where the length of liquid throw equals the propeller diameter.

A propeller acts primarily as a propulsion device. Propelling efficiency is related to the projected area of the blades upon a circular plane with a radius equal to the propeller radius. Marine propellers are designed to utilize a maximum quantity of this area consistent with structural design. Propeller efficiency also depends on correct streamlining of the blade. Unlike fans for air, however, it is not necessary to extend the leading edge of the blade to improve the propulsion efficiency.

Effective use of propellers for mixing depends largely on their displacement. In a series of geometrically similar propellers of varying diameters, only one propeller diameter need be tested for volumetric flow. Displacement is directly proportional to the square of the diameter and to the rotational speed.

Turbine Type Impellers

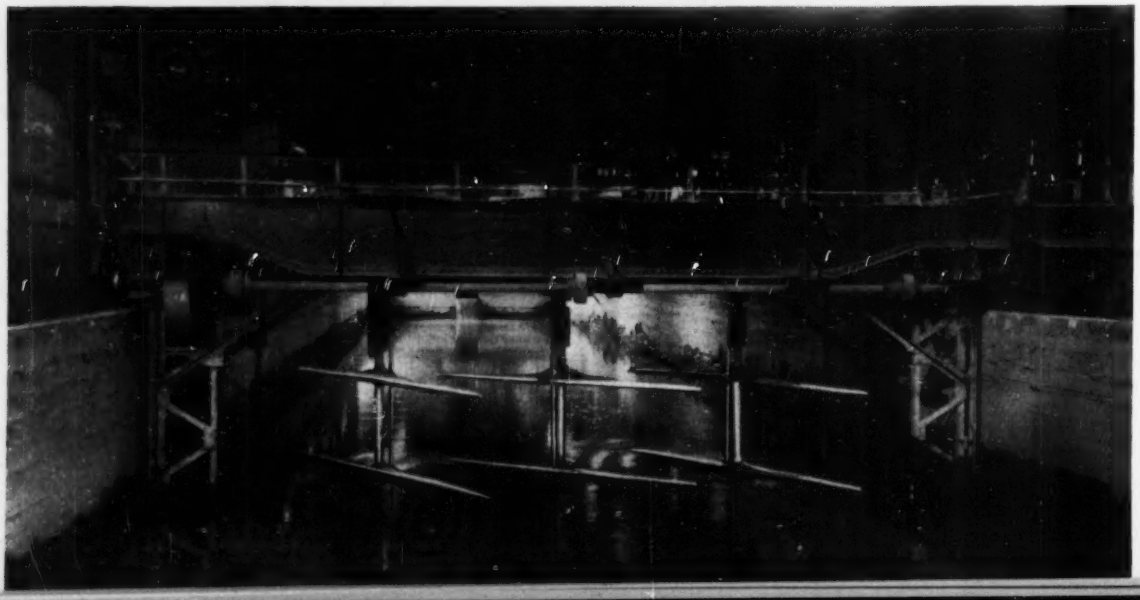
"Turbine impeller" is a loose term given to a wide variety of impeller design shapes. A number of impellers now are called turbines without regard to direction of fluid flow. Some are clearly similar to propellers. Others are like paddles, rotating at higher speeds than customarily used with paddles.

Some people have used speed of rotation to differentiate between propellers, paddles, and turbines. As yet, however, no attempt has been made to classify mixing impellers by a formula similar to the specific speed formula used for pump impellers.

It appears to the author that speed of rotation and impeller diameter or contour are actually subordinate to the flow pattern created. Thus, the term turbine will be used here to define a bladed type impeller where fluid flow is predominantly radial. An even better term might be radial-flow impeller. A variation, the mixed-flow impeller, refers to units that combine radial with axial flow.

Turbine impellers are designed with either straight or curved blades. Faces of the blades can be perpendicular to the horizontal plane, tilted at an angle to the same plane or contoured similar to the blades of hydraulic turbines.

Fig. II-10—Paddle agitator in cement plant travels back and forth along rectangular slurry tank. Paddles are suspended from overhead span that rolls on rails at the top of the tank wall. On this job it's easier to move the agitator than to provide for movement of the slurry through the agitator zone. (F. L. Smidth & Co.)



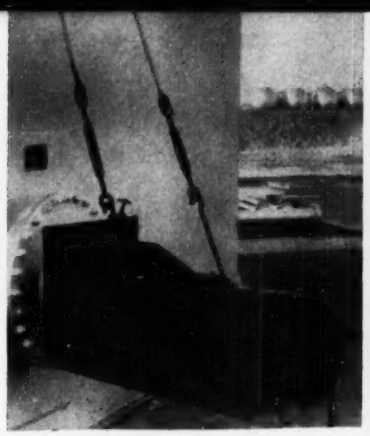


Fig. II-13a—Side-entering agitator in position on large tank in cycling plant. (International Engineering, Inc.)

Fig. II-13b—Gear-drive portable mixer turns over tank contents without vortexing. (International Engineering Co.)

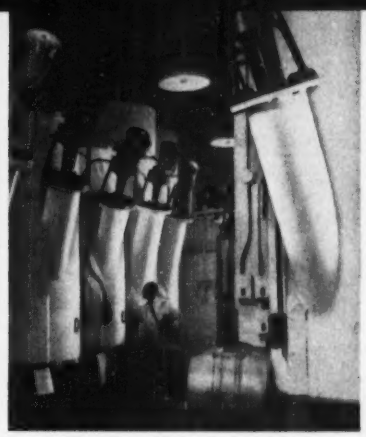


Fig. II-13c—Propeller mixers set at predetermined angle create good interchange without baffles. (Mixing Equipment Co.)

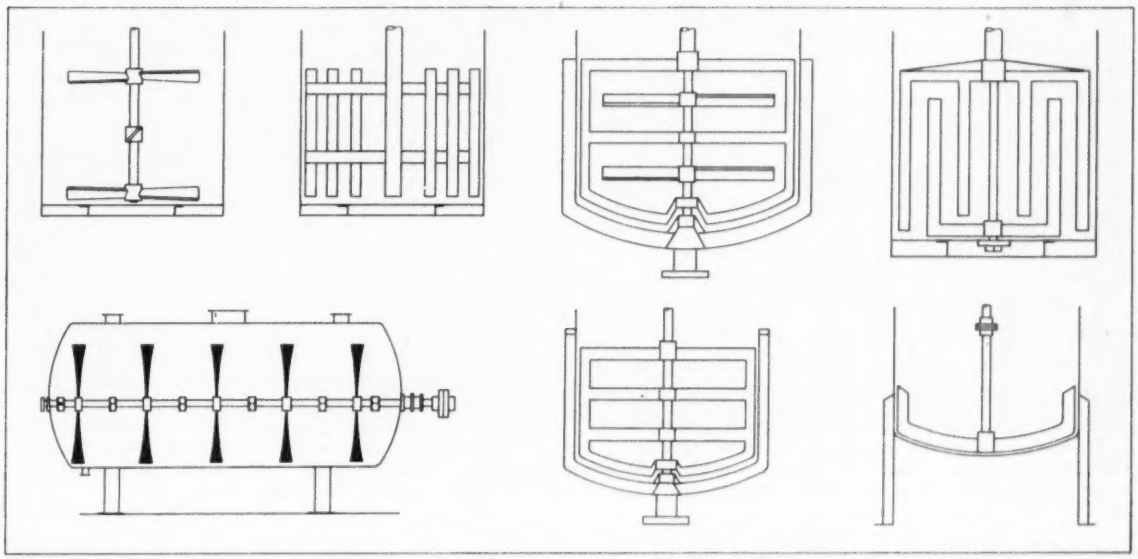
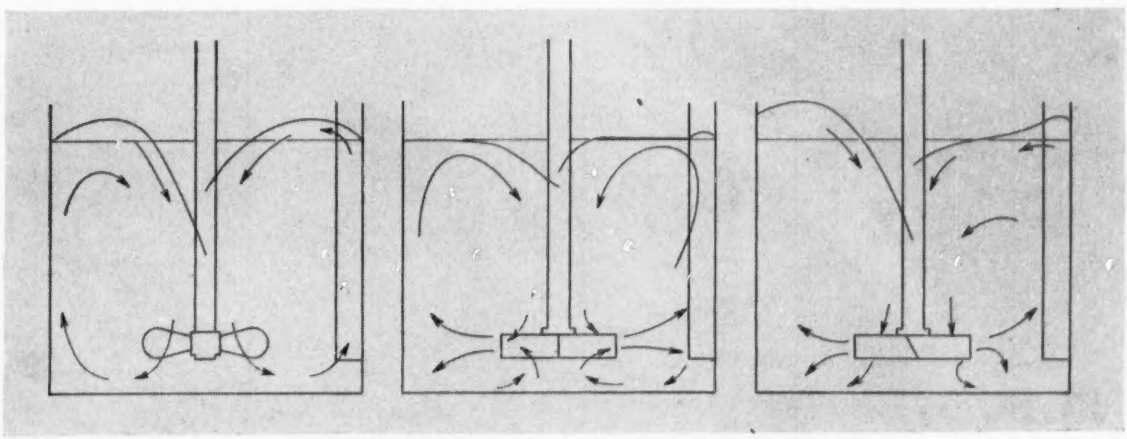


Fig. II-9—Paddles can be arranged in a wide variety of combinations, some of which are shown here. From l. to r. top: a simple paddle agitator with upper and lower blades, a gate paddle, a double motion agitator, a finger paddle combination and from l. to r. bottom: a horizontal cylindrical vessel with multiple paddles, a paddle for heated vessel and an anchor agitator.

Fig. II-11—Flow patterns for impellers running in baffled and unbaffled tanks. From l. to r.; propeller mixer produces an axial flow pattern that sweeps the bottom of the vessel; straight, unpitched turbine moves liquid in a radial pattern; pitched-blade turbine makes a combination radial-axial flow path. Baffles cut swirl and reduce vortex for better turnover of liquid.



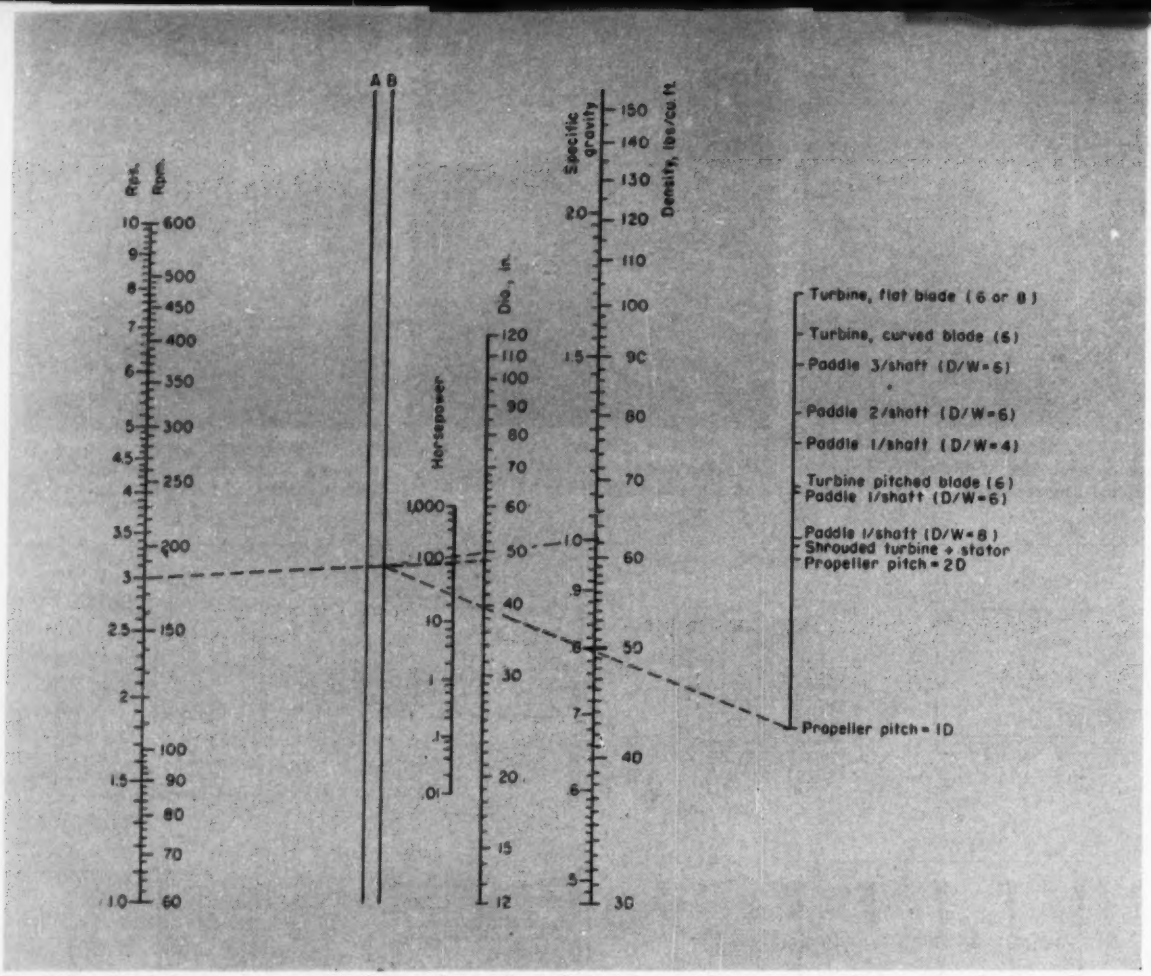
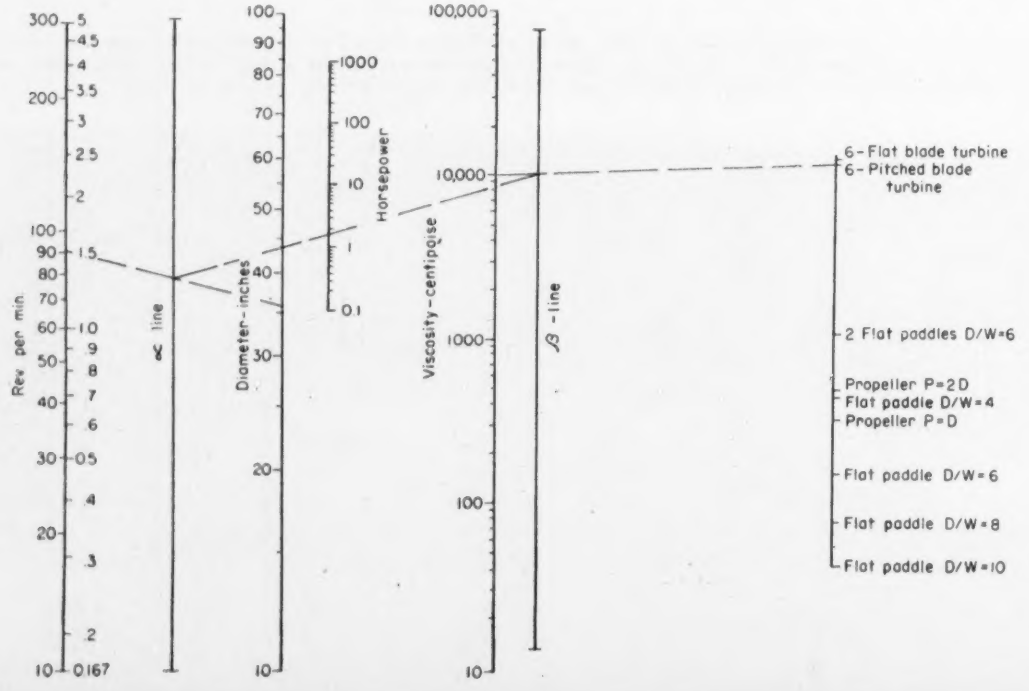


Fig. II-14a—To find power consumption by impellers under turbulent flow conditions you should know impeller type, diameter, speed and batch density. Then connect Rpm. with Dia. The intersection with A, connected to the Density scale, makes an intersection on B. A line from this point to the Impeller scale intersects the Horsepower scale at the correct value.

Fig. II-14b—Where mixing is done with laminar flow conditions this nomograph will give power consumption if you know impeller type, diameter, speed and viscosity. Connect Rpm. and Dia.; also Viscosity and Impeller scale. The intersections of these two separate lines with alpha and beta respectively then can be connected to give the Hp. value at the insection with the Hp. scale.



The blades can be open, or encased in single or double shrouds, or provided with a mid-feather. Originally, the turbine was used in conjunction with a stationary deflecting-blade ring. This corrected the tendency for the fluid to swirl after leaving the impeller blade tips. Various modifications of the turbine impeller are shown in Fig. II-15.

Blades in a turbine are curved primarily to improve flow efficiency by more smoothly converting input power to liquid momentum. From the standpoint of liquid displacement, the turbine impeller is like the propeller. Its efficiency as a mixing device can be enhanced by improving its volumetric displacement or pumping capacity so as to utilize input power more efficiently. Depending upon the fluid viscosity, the radius of action can be extended and the mixing obtained in a shorter time interval through turbulence created by baffles, vessel wall and tank shape.

Baffles should be used in all cases where liquid viscosity is not sufficient to control swirl. Lyons (Lyons, E. J., *Chem. Eng. Progress*, **44**, No. 5, p. 344, 1948) points out that baffles can be eliminated for viscosities greater than 60,000 centipoises. Above this point, viscous drag is sufficient to control swirl and assure vertical circulation. Fig. II-11 shows flow patterns from both the mixed-flow pitched-blade turbine and the curved or flat-bladed turbine.

Disk & Cone Impellers

A disk rotating in a fluid displaces by centrifugal action the fluid in contact with its surfaces. Uniquely, the disk impeller provides 100 percent radial flow with a low degree of mechanical shear.

Disks ordinarily are made of thin plates, but the thickness can be varied considerably. The frictional effect producing flow is proportional to the surface area of the disk faces. Increasing thickness to enlarge peripheral area has only a slight effect on agitation and power consumption until the thickness becomes pronounced. Of course, with a thick disk the radial flow will be supplemented by tangential flow.

Disk impellers can be used for high-viscosity fluids where propellers or other types of impellers are impractical. They can smooth pastes where the batch is sufficiently small to allow complete flow of the fluid within the vessel. Cotton-dyestuff printing pastes are handled in this fashion. If the disk surfaces are smooth there is minimum attrition of solids suspended in the liquid. Thus, disks can be used on paper pulp, crystalline slurries, and other easily damaged solid particles.

With disks, the volume affected by agitation is limited. Still, the radial flow characteristic is suited to shallow vessels. Another desirable feature is the disk's inherent balance which permits smooth operation at high rotational speeds. Two or more disk-type impellers, Fig. II-18, can be mounted on the same shaft. Performance can be varied within the limits of the motor capacity by changing spacing, number and diameter of the disks to suit the immediate needs.

An outstanding use for high-speed disk impellers is for dissolving and dispersing work. One such unit, Cowles dis-

Fig. II-15—Turbine configurations vary considerably to fit a variety of mixing needs. Different designs produce different flow paths, depending, of course, upon the size and shape of the vessel and the presence of baffles, coils and the like. An example of design to meet a need is (g) for increasing the vertical blending action on viscous liquids.

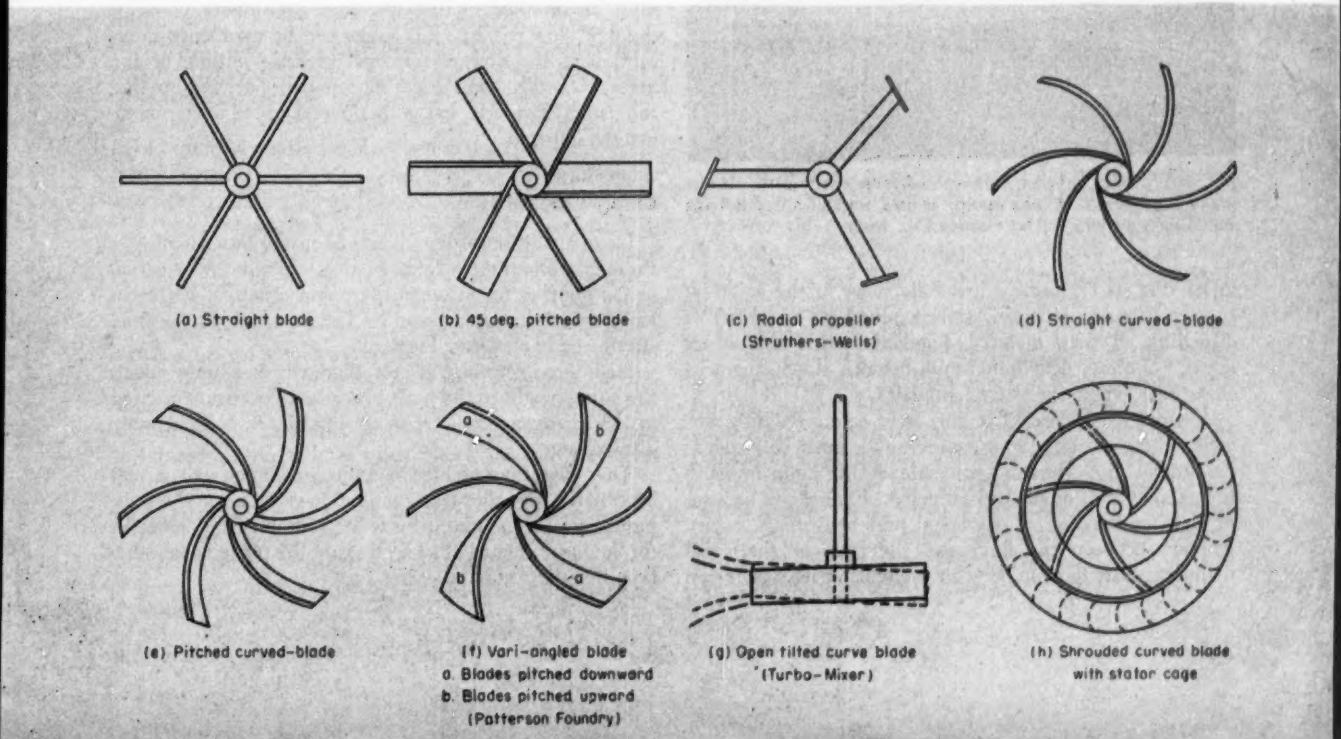


Fig. II-16—Looking into penicillin fermenter you see three turbines mounted on a single shaft with sparging rings located in the intermediate zones. (Turbo-Mixer Div.)

Fig. II-18—Serner design disk impeller allows maximum operating flexibility. Spacing, number or diameter of disks can be varied. (H. E. Serner Co.)

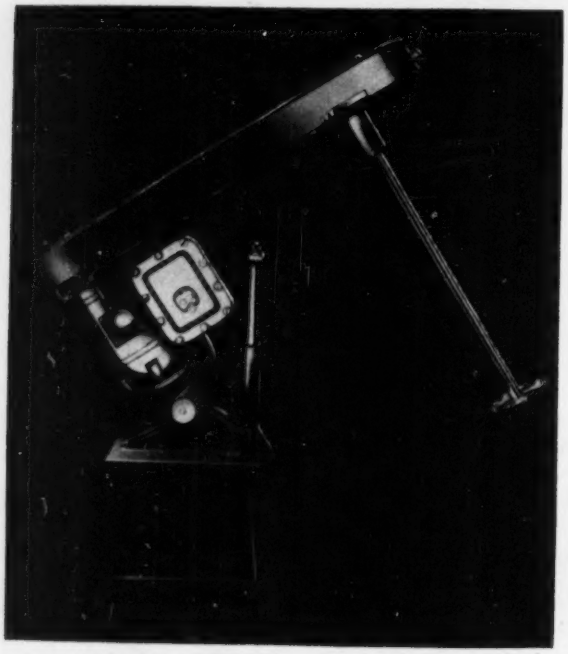


Fig. II-17—Disk impeller with specially designed teeth on the periphery operates at high speed, is used for difficult dissolving and dispersing jobs. (The Cowles Co., Inc.)

solver, Fig. II-17, utilizes hydraulic shear in the agitation zone to decrease drastically time required for dissolving or dispersing. Typical materials handled in this fashion are resins, Gilsonite, dehydrated milk powder, starch, pigment chips, clay, cellulose esters, and latex.

A truncated hollow cone can serve as an agitating impeller where attrition of suspended solids must be avoided. Essentially, the operating principle of the cone impeller is similar to that of the disk impeller. Fluid flows because of the combination of frictional and centrifugal forces. Friction between the fluid and the cone at the small diameter starts fluid moving in a circular path inside the cone. Since it is moving in a circular path, the fluid is subjected to centrifugal force which makes it move within the cone toward the larger diameter. As it moves in this fashion it continually accelerates, picking up momentum.

Several modifications have been developed for the cone impeller. One joins the bases of two truncated cones so that there is a circumferential gap at the point of largest diameter. When this impeller is rotated at high speed it produces a radial type of fluid flow.

A standard cone impeller can be modified to increase rate of shear by adding vanes to the outside surface. Still further gain is obtained by notching the outside edge of the vanes. Use is found for this unit in dissolving rubber or cellulose esters where a gelatinous layer tends to form around the particle.

Unmodified cone impellers are particularly effective for keeping chemical cotton fibers in suspension. The impeller must be installed so that it provides a smooth path for the fluid flow pattern. No baffles can be used since interruption of the flow pattern will produce settling of the fibers. On this application the cone is operated so that the larger diameter has a peripheral speed of approximately 700 fpm.

Pump Recirculation

Large quantities of liquids can be mixed by recirculation through a pumping system. Mixing is produced by action of the impeller or piston in the pump chamber, by turbulent flow in the piping, and by free-jet action as the fluid stream discharges into the tank.

High head pressure is not required; it simply equals the liquid height in the tank, plus that to overcome friction in the piping system. Of more importance is high pump displacement.

This condition of high capacity and low head is met best by the propeller type pump. However, since the same pump may be used both for recirculation mixing, and also for liquid transfer to other sections of the plant, some other type of pump may be called for.

Paste Mixing

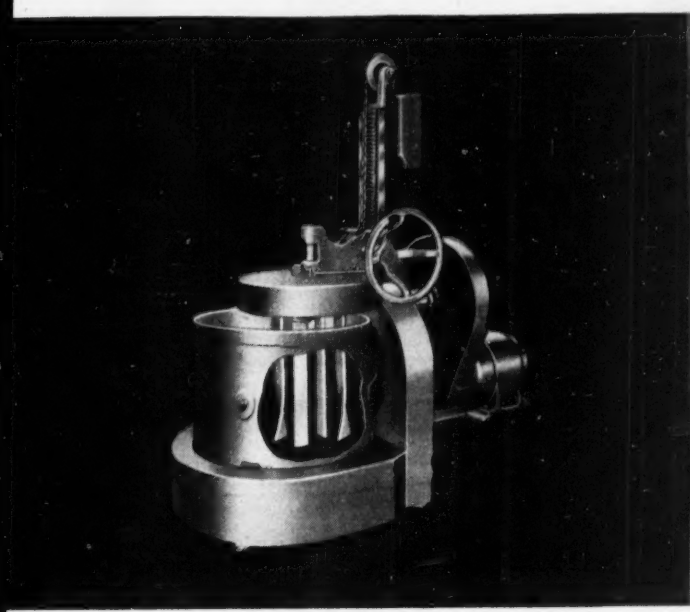


Fig. III-1—Pony type change-can mixer has finger paddles operating from stationary off-center position while can rotates. Counterweighted paddles lift easily. (Chas. Ross & Son Co.)

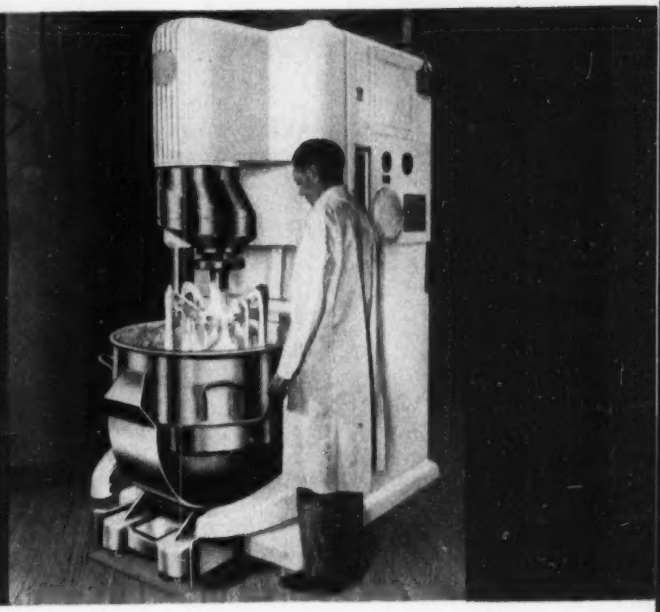


Fig. III-2—Planetary change-can mixer holds container stationary while agitator rotates and simultaneously moves in circular path around can. (American Machine & Foundry Co.)

Proper choice of a paste mixer is governed not only by the consistency of the final paste but also by the starting conditions in the mixing cycle. Thus, the cycle may start with addition of solid to liquid—or the reverse condition, with the addition of liquid to solid.

Impeller mixers using turbines, paddles and anchor agitators obviously must be used only on those paste mixing jobs where the starting material is liquid. Kneaders, barrel and ribbon mixers can be used with either a liquid or solid phase during the initial steps of the cycle. But note that they must be designed with adequate strength to handle the paste in its most viscous condition.

Between these two extremes which we encounter in paste mixing there is a zone where no sharp boundary exists. Thus, many mixing devices used for low-viscosity liquids also are used for more viscous liquids and pastes.

Mixing of flowable liquids with pasty or high-viscosity characteristics requires expanding the impeller or agitator action to embrace the major part of the volume of contained liquid. It is not possible to impart sufficient momentum to bring about mixing by continually creating and dispersing turbulence, since flow is too much damped by internal forces in the liquid.

Physical Properties Important

When mixing viscous liquids a correct appraisal of physical properties is much more important than with low-viscosity liquids. Paradoxically, paste properties are difficult to pin down. An incorrect evaluation of these properties easily may lead to the selection of an unsatisfactory mixer.

Paste mixing is done under laminar flow conditions where shearing action predominates. With pastes proper selection of a mixer is complicated by a wide range of viscosity and flow characteristics. Also there is need for detection of non-Newtonian properties such as thixotropy, pseudoplasticity and dilatancy.

As viscosity or apparent viscosity increases, the length of path or flow of each fluid particle becomes shorter. Attention then must be given to extending this flow path by additional impeller action. The impeller must reach every part of the fluid volume and disturb it physically by shear or actual "pushing" of the liquid.

The best way to agitate pastes is by using a multiplicity of blades in order to cover all the volume of the liquid, or by keeping batch size small enough so that simple agitation can extend turbulence throughout the vessel.

Maintaining adequate cleanliness is another problem that becomes more acute with high-viscosity liquids. Pasty materials tend to cling on vessel walls and agitator blades. Hence, interior construction of the vessel should be streamlined to minimize holdback of material. The agitator should be self-cleaning while operating. Both agitator and vessel must be easy to clean to prevent contamination.

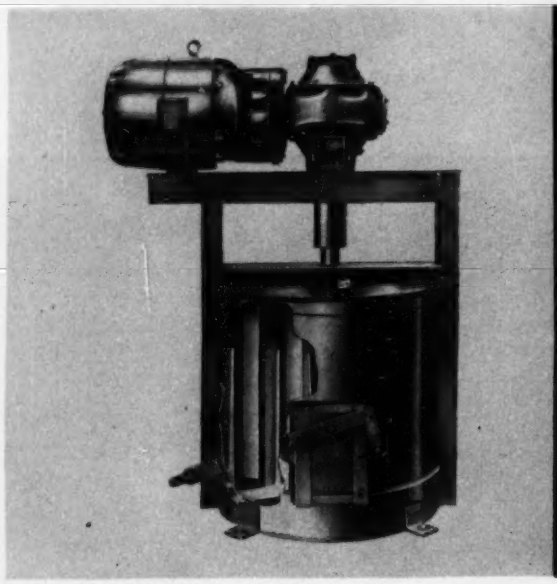


Fig. III-3—Heavy-duty paste mixer employs both moving and stationary finger paddles to provide good interchange throughout vessel. (Charles Ross & Son Co.)

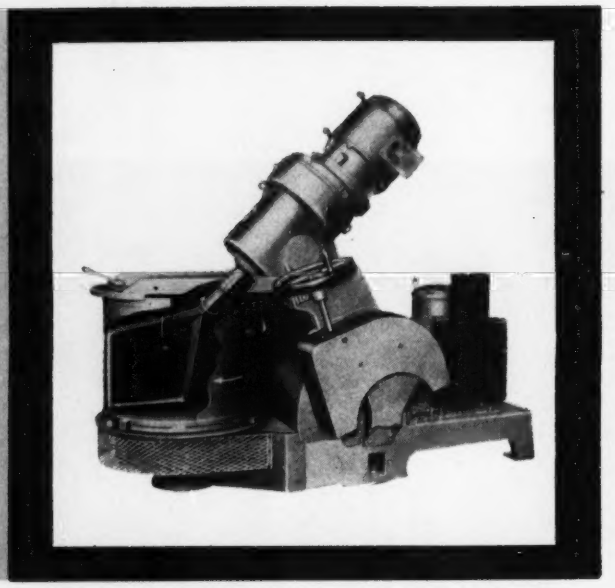


Fig. III-4—Angular type change-can mixer has 4-sided agitator that projects into chime. As can revolves all zones are mixed. (Troy Engine & Machine Co.)

Power consumed in mixing viscous materials is proportional to apparent viscosity, speed of rotation to the second power, and impeller diameter cubed. Viscous liquids and pastes offer more resistance to working and require much more power per gallon than the more fluid liquids. Therefore, machines for this type of mixing are built heavier. Members such as agitator blades, bearings, gearing and drives must carry these heavier stresses.

Equipment Line-up

An initial classification of mixers for higher viscosity liquids can be made on the basis of container rather than impeller type. With such a wide range of flow characteristics, batch size and shape of the vessel now are dominating factors. Below are listed mixers for high viscosity liquids in the order of their suitability as apparent viscosity increases. It will be noted that there are actually four families of mixers included in this listing comprising (1) a vertical container group, (2) a horizontal group, (3) a pan type group, and (4) a specialized group.

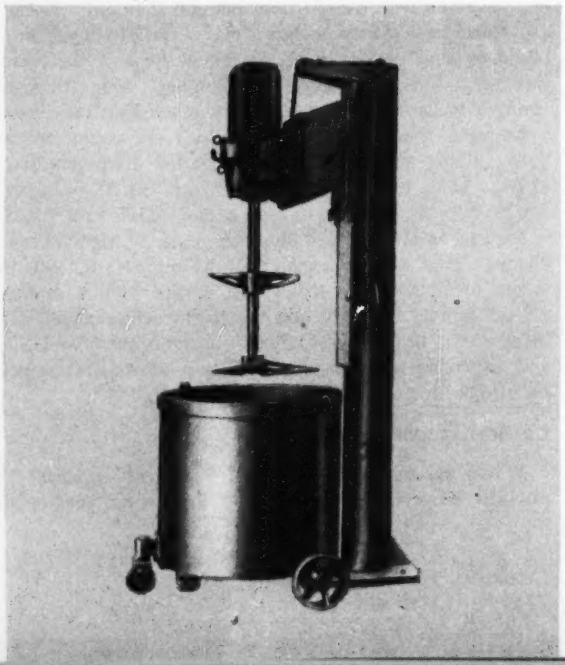
Approximate Order of Choice for Paste Mixers as Apparent Viscosity Increases

1. Colloid mills
2. Ball mills
3. Tube mills
4. Straight-arm paddle mixers
5. Intermeshing paddles
6. Pony mixers
7. Horizontal trough ribbon mixers
8. Disk impeller mixers
9. Double motion paddles
10. Planetary paddles
11. Pan mixers, either wheel or pan rotating
12. Vertical spiral screw crutchers
13. Pug mills
14. Sigma blade mixers
15. Horizontal mixers, scraper or blade type
16. Horizontal mixers, continuous dispersion
17. Dissolvers (digesters)
18. Horizontal mixers, spiral ribbon blade

Selection Factors

Various factors influencing the selection of a mixer are outlined on the following page.

Fig. III-5—Post-type change-tank mixer provides quick, easy lifting of agitator from vessel. Large impeller moves slowly, scrapes bottom. (Charles Ross & Son Co.)



Factors to Consider in Choosing a Paste Mixer.

1. Physical properties of dominating liquid condition.
   a. Thixotropic (apparent viscosity will decrease).
   b. Dilatant (apparent viscosity will increase).
   c. High Newtonian viscosity (viscosity will remain constant)
2. Procedure during operation.
   a. Liquid becomes plastic, then paste (as in the addition of a soluble powder to liquid).
   b. Powder becomes plastic then paste (as in the addition of liquid to a soluble powder).
   c. Continuous input (i.e. for emulsification).
3. Shape and size of mixing container.
   a. Strength of machine members.
   b. Cleanliness of vessel interior.
   c. Small or large batch.
   d. Discharging characteristics.
4. Other factors.
   a. Power consumption characteristics.
   b. Change can for easy handling.

If a high viscosity liquid has true Newtonian viscosity it may possess high fluidity even though viscosity is appreciable. In that case impeller mixers including plain paddles, turbines, disks, anchor agitators and planetary paddles can be utilized.

Impellers can also be used on thixotropic liquids which break down to a lower apparent viscosity when agitated, and pseudoplastic materials like cellulose acetate solutions, cooked starch pastes, and some emulsions. Dilatant materials or materials requiring continual shearing forces cannot be mixed efficiently by impellers of this type.

The simple paddle with proportions of width to length lying in the range between 0.12 and 1.0 often is used for higher viscosity mixing up to Reynolds numbers of 10.0. It has been observed in the laboratory (Hirsekorn and Miller, *Chem. Eng. Progress*, **49**, 459, 1953) that flat paddles $W/L = 0.17$ are effective for viscous agitation of suspensions of slow settling solids in liquids, in cases where liquid depth equals tank diameter. Ratio of agitator diameter to tank diameter must not be less than 0.6. Effective suspension of slow settling solids (10^{-4} to 10^{-3} ft./sec.) was achieved with such paddles using 1.5 to 2 hp. per 1,000 gal.

Curved-blade turbine agitators long have been favored for mixing high-viscosity liquids. Apparently the reason is use of low rotational speed where power consumption is favorable, and also sturdiness of the turbine construction. A disperser ring is not used with the more viscous liquids, but does prove useful when maximum shearing is desired as in some resin dissolving operations. Both curved- and fan-blade turbines are used for viscous liquids.

High-speed disk impellers are used for mixing more viscous liquids and dispersions. Impeller diameters range from 4 to 30 in., with corresponding speeds from 5,500 down to 500 rpm.

Disk mixers are manufactured for installation on tanks or with a hydraulic lift mechanism for change-can duty. Motor sizes vary from 3 to 40 hp.

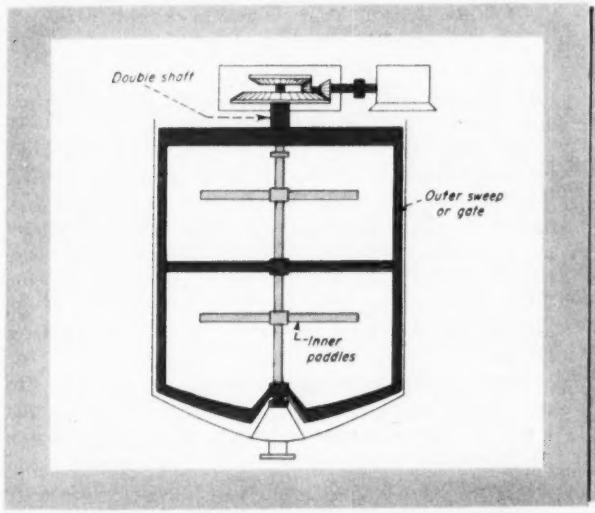


Fig. III-6—Double-motion gate and paddles mixer agitates entire volume of batch, is used on soap and grease. Gate and paddle rotate in opposite directions.

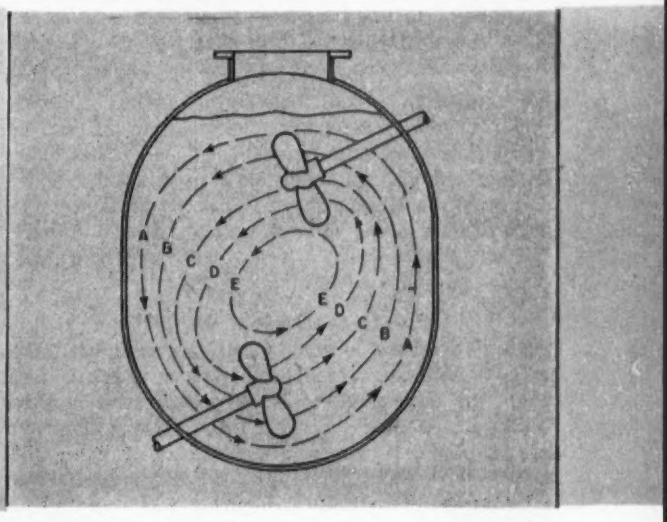


Fig. III-7—This combination of special vessel design and impeller location extends propeller range to higher viscosity, is used for rubber cement. (Struthers-Wells)

Change-Can Mixers

Planetary finger paddles operating in the vertical position can be used for paste mixing. One type of change-can mixer, termed the pony mixer is used extensively throughout the paint and varnish industry. It is equipped with this type agitator, as Fig. III-1 shows.

The vessel is an important factor with this type of mixer. It is designed ordinarily to rotate on an axis eccentric to the axis of the paddle shaft. This planetary motion provides mixing in all zones of the vessel. The action has some favorable characteristics, although the rate of mixing is slower than for other impeller mixers.

Heavy pastes, such as white lead and starch dispersions, gum dispersions, and the like can be mixed in paddle

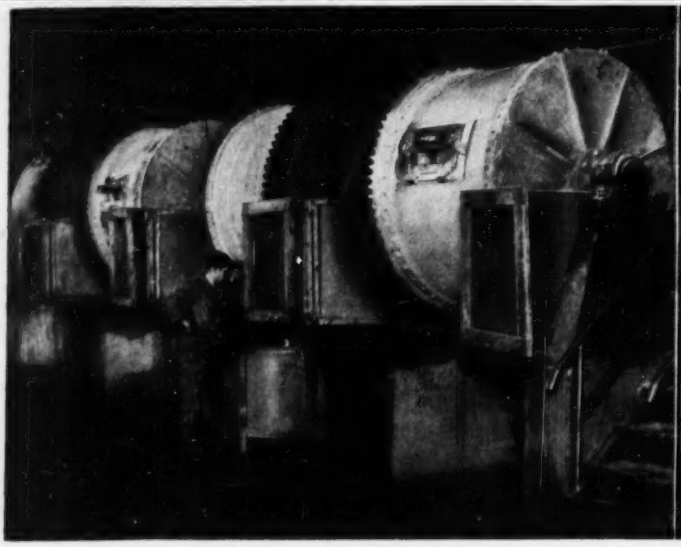


Fig. III-8—Tandem ball mill performs mixing as well as grinding. On hard-to-disperse pigments and resins it is used primarily for mixing. (The Stevenson Co.)

Fig. III-9—Battery of 15 Bramley mills needs only one operator. Many are used in chocolate industry. (Bramley Machinery Corp.)

mixers with paddles rotating at speeds from 20 to 50 rpm. Paddle mixers for this application use rotating paddles operating in conjunction with stationary blades. Either a vertical or horizontal installation of paddles and stationary bars can be used, although the vertical type is preferred for better mixing during withdrawal of the paste.

Power requirements for laminar-flow finger or reel paddles can be computed as follows:

$$T = C_D\ (\rho A/2g)\ (r_1\ v_1^2\ r_2\ v_2^2 \ldots .)$$

where T = torque, in ft.-lb.; C_D = drag coefficient (taken as 1.7 in. of water if peripheral speed of paddle is about 1.8 ft. per sec.; ρ = density; A = equivalent projected surface area of paddle = (W x L); r = radius of rotation of each paddle, ft.; v = peripheral velocity of each paddle, ft. per sec.; and g = 32.2 ft. per sec.^{2}. The subscript numbers distinguish the paddles at various radii. For example, r_1 is the radius for the paddle closest to the axis, r_2 for the next closest and so on. Horsepower = $12TN/63{,}025$ where N = rpm.

Power needed for combinations of horizontal and vertical paddles can be computed approximately using the expressions above together with the nomograph for laminar flow, Section II, Fig. II-14*b*.

On dissolving jobs, mixing time can be shortened by decreasing the clearance between the rotating paddles and the stationary blades. Resultant squeezing and cutting action removes gelatinous particle coatings and permits penetration of solvent to the undissolved centers. The same action also is important in extending thick pastes with oils or solids.

In the paint industry there has been a tendency to prefer the change-can mixer, both the pony and the post types. Primarily, this is due to the necessity of working on numerous batches of different colors. Also with such mixers several ingredients can be weighed directly into the container can, then brought to the agitator, mixed and moved to the next operation.

The pony mixer (Fig. III-1) is constructed with a set of blades arranged to operate from an overhead drive. This assembly can either be raised by a gear and rack device, or tilted back over its stand. The can rotates on a platform, driven by gears or belts from the same motor which drives the overhead blades. Since the blades are off center in relation to the vertical axis of the can they sweep through the batch and wipe the inside of the can.

Several variations of agitator design are available. In one type a set of four blades is used, while in another a pair of U-shaped blades intermesh as in an egg beater. Another more modern design, the Troy mixer, has a diamond shaped agitator set at a 45-deg. angle, as in Fig. III-4. The point of the agitator projects into the chime of the can.

Popular sizes for pony mixers are 30, 60, and 100 gal. Other units are available in sizes from the laboratory range up to several hundred gallons.

Another type of change-can mixer is the post mixer designed for location against a post, column or wall. It is utilized primarily because of need for quick removal of the vessel. A common type uses a large impeller shaped like a propeller and rotating at 40 to 60 rpm. Called an elephant's ear, it is designed to scrape any settled material off the bottom of the can.

Double Motion Agitator

A combination of the anchor or gate agitator with one or more inner horizontal paddles is used for pastes and thick creams, such as greases and soaps. As shown in Fig. III-6, the agitator is designed with multiple paddles to agitate all zones and levels in the batch.

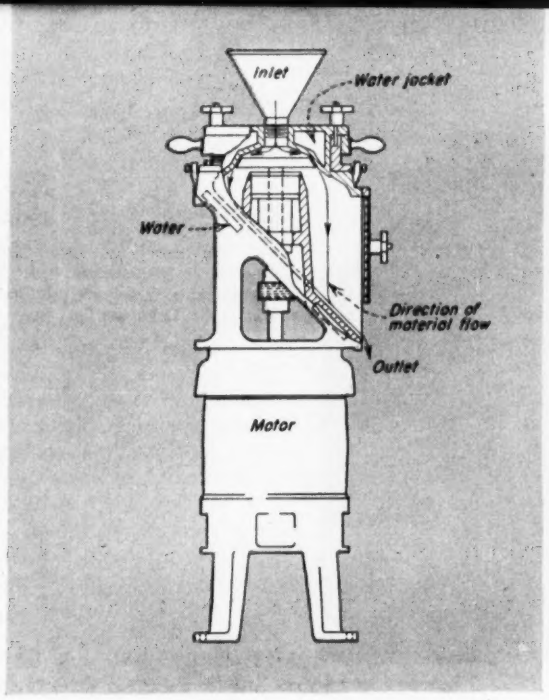


Fig. III-10—Colloid mill disperses both by hydraulic and mechanical shear. High speed rotor moves in close clearance with stationary bed plate. (Premier Mill Corp.)

Alternate horizontal arms of the gate and separate paddles rotate in opposite directions, utilizing a double-motion drive. If the paste is sufficiently fluid the arms are tilted at approximately 45 deg. to provide thrusting effect.

The anchor gate frame conforms to the inner surface of the vessel. Scrapers can be attached to the outer edge of the frame to scrape the vessel wall.

Several types of agitators use a pushing action to displace material in the mixer. Examples are anchors, gates, rakes and screws. Ribbon type devices sometimes are used in kettles for circulating granular or crystalline solids.

. . . III—Paste Mixing

Most viscous liquids are heated in jacketed tanks to decrease viscosity. The anchor agitator, shaped to conform to the inner wall and bottom of a vessel, works well on such material. It displaces material next to the wall, increasing the rate of heating.

Length of the anchor arms varies with design of the vessel and with the extent of the heating surface. If the anchor arms extend up the side of the vessel the ends may be supported by cross arms to the shaft. In most cases the anchor arms are parallel to the driving shaft, but they may be tilted to force the material upward.

Gate agitators are used occasionally for heavy-duty work. The gate with vertical spokes finds use as a blunger in preparation of a clay slip. Clay is charged to the tank in large lumps which cause heavy shock to the agitator mechanism.

Screw agitators similar to screw conveyors sometimes are used in soap crutchers and grease kettles. They operate by simple displacement, pushing the material along by action of the screw helix. Material obviously must have sufficient body so that it will not slip out of the cylindrical volume traversed by the screw. Speed of rotation governs efficiency of the displacing motion.

Barrel and drum-type mixers include ball mills with balls or pebbles for grinding, mushroom mills with or without balls, and drums. Mills with grinding media are designed primarily for grinding, yet mixing also takes place. Such mills are selected as mixers primarily if the solids are dispersed with difficulty.

In the paint and varnish industry ball mills (Fig. III-8) are strongly entrenched because of three factors: the need for grinding and dispersion, the necessity for batch operation, and the fact that flammable liquids are used.

Moderately high viscosity is needed in ball mills to reduce abrasion on the interior lining. On the other hand, viscosity must not be so high that the liquid cannot flow.

Fig. III-11a—Dispersall mixer for thin to heavy slurries uses vaned-rotor milling element and slotted draft tube circulation system. (Abbe Engineering Co.)

Fig. III-11b—Dispersall mixer for pastes has cupped rotor-stator mixing element and double rotating paddles to circulate material. (Abbe Engineering Co.)

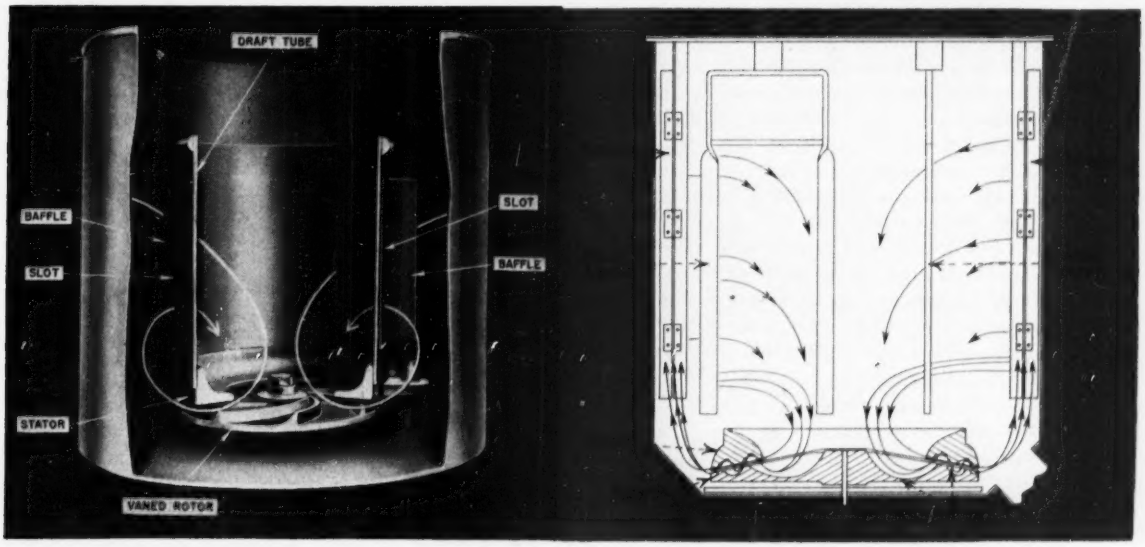


Fig. III-12—Three roll horizontal mill operates with differential roll speeds to disperse pasty materials such as pigment in vehicle for printing ink. (J. M. Lehmann Co., Inc.)

Trough Mixers

Liquids ranging from water to medium pastes can be mixed in horizontal trough-shaped or cylindrical vessels. The major use is for handling batches where liquid ingredients are added to dry materials. The agitator on a horizontal shaft can be supported from bearings in the two end walls, which is a very sturdy type of construction.

A common trough type mixer is the ribbon type discussed in Section V. Although its main use is for solids, it finds use also for liquids and pastes.

Other designs for trough type agitators can be classified either as spirals, or as the gate-and-inner-paddle type. Also, finger-type paddles have been used.

Location of the discharge port in the bottom of the trough or drum has some effect on agitator design, although less than with materials that cannot flow. For best results the speed of rotation should be in the range of 50 to 80 rpm., depending on batch volume and peak viscosity during the mixing cycle.

Level of the mix in the trough sometimes is critical. It depends on liquid viscosity. Optimum level is between the shaft and the topmost point of travel of the agitator. This can be exceeded only if viscosity is fairly low, between 2,000 and 4,000 centipoises.

A unique mixer and processing mill for pastes such as chocolate is the Bramley Mill shown in Fig. III-9. Here spring-mounted blades attached to a centrally located rotor rub against thin steel strips on the inside of the cylindrical vessel. This action aids in dispersing agglomerates.

Medium- to heavy-consistency pastes are often made in kneaders of the double-arm or sigma-blade type. Originally developed for dough mixing, and discussed fully in Section IV, this unit is used widely because of its general over-all efficiency in small-batch mixing.

During some mixing operations the paste passes through a very stiff plastic stage. A sturdy, heavy-duty sigma-blade mixer can withstand the high stress imposed on the agitator blades by such a paste.

Inherently, this mixer has sturdy structural design, with short distances between the two agitator bearings. If necessary, blades can be thickened to strengthen the cross-section. Such kneaders mix efficiently, permitting short cycles. Thus, costs compare favorably with other types of units.

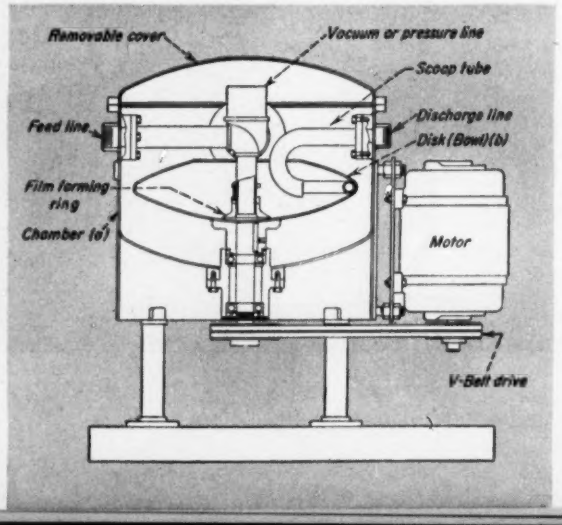
Double-arm mixers with sigma blades can be made in the small to medium sizes with a tilting arrangement for emptying the bowl or trough. This facilitates discharging of the trough contents.

Mills

There are a number of mills designed for dispersion purposes on the market. Most of these devices have a high-speed impeller rotating close to a stationary bedplate. This provides both hydraulic and mechanical shear by impingement. Also, the rotor has a displacing action similar to that of a disk impeller.

Colloid mills and the Abbe Dispersall are included in this category. In general, the colloid mill must be preceded by a suitable pulverizer to prepare feed particles that are

Fig. III-13—Centrifugal action of the Versator spins material across bowl surface. Turbulence and shear produce a high degree of dispersion and homogenization. (Cornell Machine Co.)



all smaller than 80 mesh. This is essential because of close clearances and the need to maintain good flow capacity and avoid undue wear on working surfaces.

The Abbe Dispersall mixer, in two models, Fig. III-11a, b, handles a wide range of slurries and pastes. For slurries ranging from thin to heavy, a vaned rotor and a slotted baffle stator are used. Heavier mixes and those where agglomerates must be dispersed are handled with a cupped rotor-stator element used in conjunction with double-rotating planetary finger paddles. The cupped rotor-stator design also is used where faster mixing is desired.

Among the materials handled on this mixer are carbon black dispersions, enamel pastes, mineral oil and ointment emulsions, paints, pigmented lacquers, cements, clay casting slips and adhesives.

For slurry mixing, the Abbe Dispersall uses mixing disks from 3⅜ to 27½ in. in diameter, in vessels holding from ½ to 330 gal. Required horsepower runs from ¼ to 25.

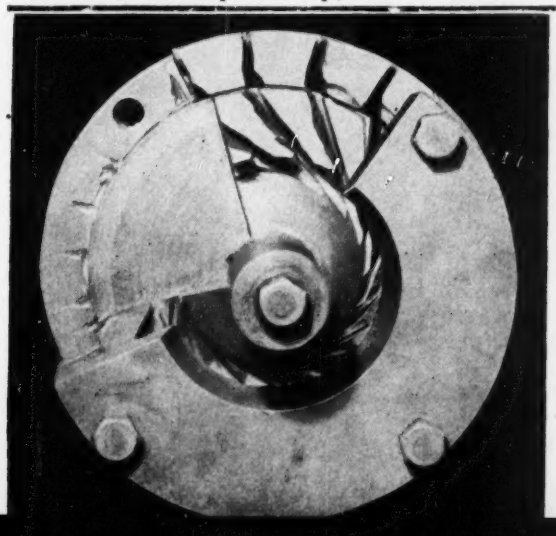
On pastes, the cupped disks have diameters from 7⅛ to 22¾ in., for batch volumes from 5½ to 220 gal. Horsepower for the finger paddles and scraper blades is ¼ to 3; for operating the rotor, 2 to 40.

In the paint and chocolate industries roll mills (Fig. III-12) are used to grind and disperse solid particles into a paste matrix. Premixing of solid particles and liquid vehicles produces a fluid paste which is then run through the roll mill for final dispersion.

Mills are built with either three, four or five rolls. Rolls revolve at different speeds, so that paste is passed from the lower to the higher speed rolls in succession. Spacing between rolls is set to pass only the desired size product. A rubbing action aids in dispersion of the solids. Rolls are cored for water cooling.

The Versator is a unique centrifugal machine used for mixing lube oils and dispersing additives therein. Centrifugal force creates turbulent flow by shear forces. As shown in Fig. III-13, this machine consists of a vacuum or pressure chamber mounted on a base. Inside the chamber is a 26-in. diameter open bowl. The bowl rotates at speeds varying from 900 to 2,000 rpm.; most processing is done between 1,400 and 2,000 rpm.

Fig. III-15—Work head of Kady mill shown in cutaway section illustrates path of solid particles by erosion marks that develop with time. (Kinetic Dispersion Corp.)



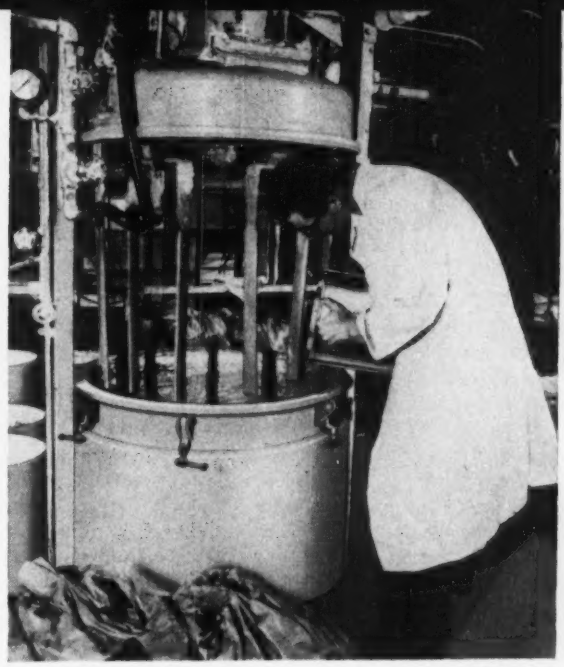


Fig. III-14—Dispersall paste mixer is constructed with paddle agitators and drive mounted on the detachable cover shown in raised position. (Abbe Engineering Co.)

Feed enters the unit through a 2½-in. connection terminating in a film-forming ring set close to the bowl surface. This ring, which can be either fixed or spring bladed, is preset to determine the initial thickness of the entering film. Pressure and rate of flow must be held constant.

When material hits the spinning disk, centrifugal force drives the mass away from the center. As it moves to the larger diameter, surface increases rapidly. Correspondingly, the expanding film decreases in thickness and the entire mass approaches the characteristics of a two-dimensional surface.

Due to the influence of wetting or adherence to the surface of the disk, and to the curved flow path, gravity, viscosity, cohesion, surface tension and centrifugal force, the mass is subjected to forces of successively varying intensity.

By operating either in a vacuum or under pressure, with preheated or pre-cooled material, a wide range of results can be obtained. In addition to mixing, this unit can perform dehydration, distillation, degasification, homogenization and emulsification, irradiation, and certain diffusional processes.

Power required is approximately 7½ to 20 hp. at 1,800 rpm. for a throughput ranging from 7½ to 75 gpm. Auxiliary equipment such as feed and vacuum pumps may require 3 to 7½ hp. additional.

A relatively new piece of equipment in the dispersion field utilizes centrifugal force to disperse agglomerates by impact and attrition. Consisting of a rotor-stator head the Kady mill, shown in Fig. III-15, is mounted in the bottom of a tank containing the liquid being processed. This high-speed impeller slings agglomerates into slots in the stator ring. There, the mass is stopped by impact on the slot walls. The accompanying attrition makes quick work of the dispersion job. Since no shear is required to obtain dispersion, non-viscous liquids can be used to avoid agglomeration in the initial step.

Plastics Mixing

Materials with pronounced plastic properties such as clay, pigment-oil dispersions, putties, doughs and plastics require heavy machinery for mixing. The types of mixer used for such purposes include kneaders, mullers, pug mills, intensive internal mixers and mixing rolls.

Since flow and momentum effects are absent in the mixing of materials of this type, the ingredients of the mix must be forced into admixture. Mechanical energy is employed to cut and separate sections of the plastic mix, change the relationship of the cut section to the original total mass, and then force the section to intermingle with other masses by shearing and compressing. The actual mixing operation comprises the combination of kneading, shearing, smearing or wiping, folding, stretching and compressing.

General Design Problems

Forcing plastic materials into admixture requires large amounts of mechanical energy. This results in the production of considerable quantities of heat which must be controlled, even though some heating may be desirable for softening and plasticizing. The more intensive type mixers, therefore, have provision for cooling by means of jackets and cored agitator blades or rolls.

The flow of highly viscous or plastic materials is not enough to bring the material mixed into the path of the agitator elements. Some material tends to cling to walls and cover and thus escaping mixing. Covers and walls must be shaped to confine the mass to the agitated zone, and in some types plows and scrapers must be provided to turn and keep the material in the mixing zone. Also, attention must be paid to the method for emptying and in some cases filling the mixing space. Other than kneaders, which can be designed to tilt for discharge, most types must be provided with conveying equipment for charging and unloading.

In some mixing problems in the plastic field, ability to operate under vacuum is desirable, particularly in making oil-pigment dispersions where evacuation of air permits closer initial contact between pigment, resin, and oil particles. Vacuum is sometimes desired to aid in removal of water which is either a constituent of the mix or is formed during mixing by a chemical reaction. In vacuum pugging of clay, removal of air gives a denser product, stronger and free from laminations.

Since plastic mixers generally require complete cleaning after each batch, the interior of the mixing zone should be streamlined for easy cleaning. Most such mixers are generally free from corners that can retain unmixed material. Proper streamlining also permits easy discharge.

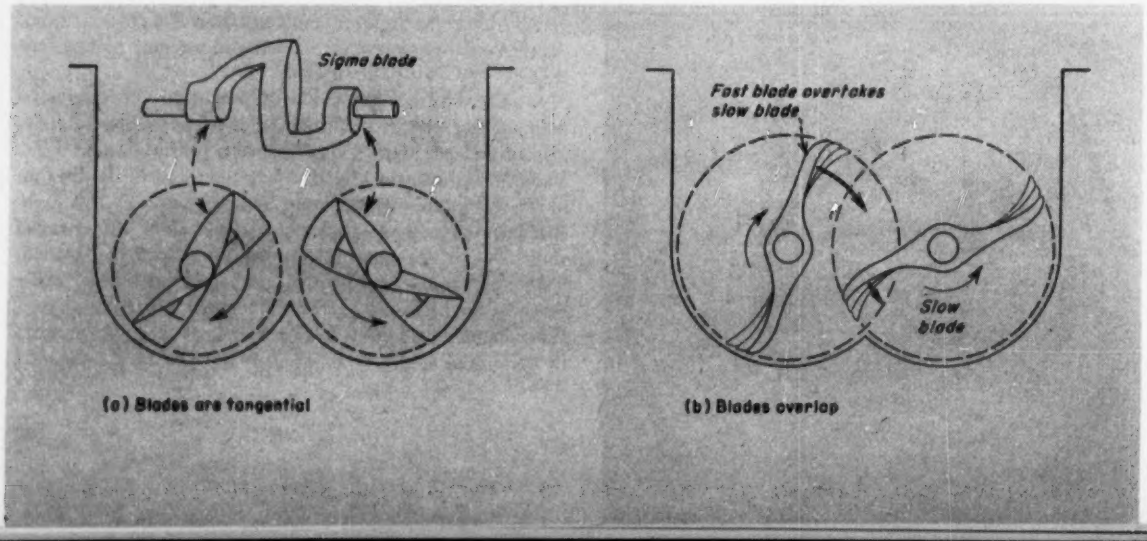
Because these mixers take large amounts of power, very heavy construction is required, resulting in great weight which means the need for firm foundations and strong emplacement design. The heavy drive poses unique problems in arrangement of the component parts in order to keep floor space requirements of the unit at a minimum. In some applications the existence of severe abrasion requires the use of replaceable sections, or of hard-facing on some surfaces.

In addition to mixing, some of the heavy-duty machines may be used for the operation known as fluxing. Fluxing means the converting of a pre-mixture of solid materials into a plastic mix by means of heat or the use of solvents. The initial solids can be mixed in light-duty pre-mixers, such as ribbon mixers, but the fluxing requires the use of heavy-duty intensive mixers or extruders.

Double-Arm Kneaders

The present-day kneader (sigma-blade or double-arm mixer) is one of the principal machines in the plastic mixing field. It can be used for mixing of all types of materials, but is generally reserved for semi-dry or semi-plastic masses, pastes, and viscous doughs. It can also be used for drying plastic masses, and for carrying out chemical reactions, such as acetylation, rubber washing or other washing processes, or dissolving operations. Exceptionally fine dispersions, such as those produced by the paint and varnish industry, are made in mixers of this type.

Fig. IV-1—At left sketch (a) is a schematic cross-section of the sigma-blade type of kneader which generally has the tangential arrangement shown, with non-overlapping blades. At right sketch (b) shows the overlapping type of blade used in the Beken mixer which features a 2:1 ratio of speed of fast blade to slow blade. (Bramley Machine Co.)



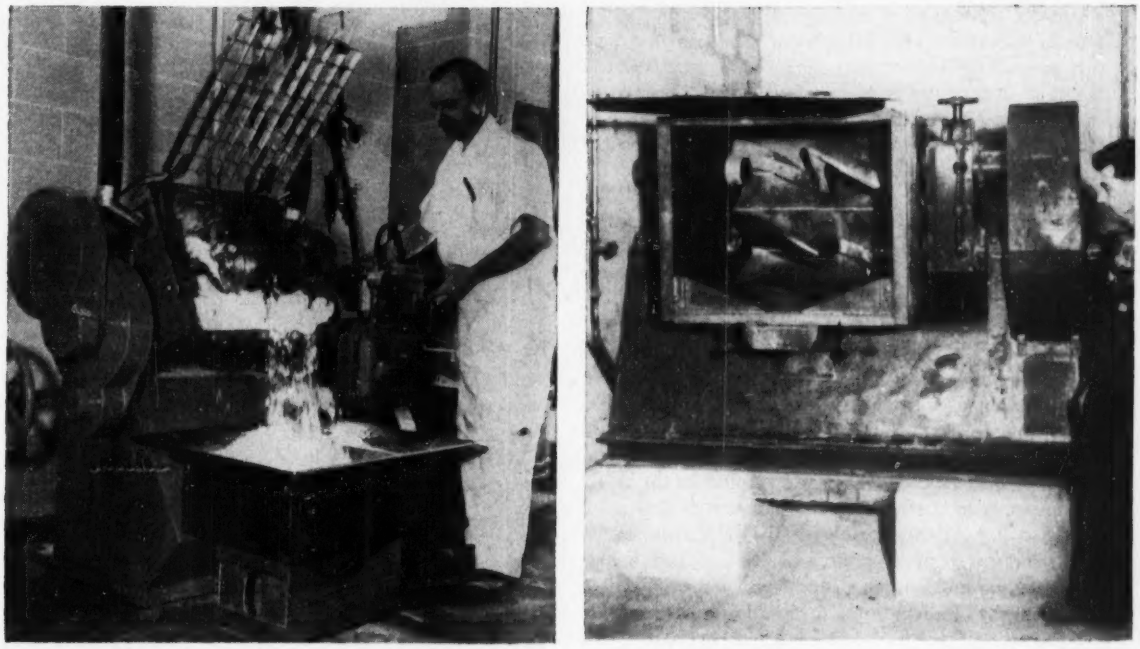


Fig. IV-3—Double-arm mixers are built in a wide variety of types and sizes, for working capacities ranging from as small as fractions of a gallon, to as high as 2,500 gal. and more. Some are open or lightly covered, as here, while others are equipped for vacuum or pressure operation. Many types of blades can be used, these having sigma blades. (The J. H. Day Co.)

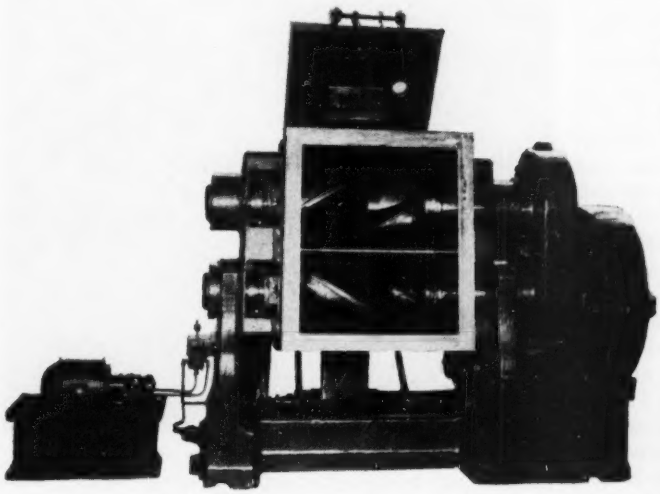


Fig. IV-2—At Left: Medium sized double-arm kneader with cover for vacuum operation, equipped with sigma-type blades. Such blades are made in many variations of pitch, weight and shape. Mixer is tilted to discharge position. (Baker Perkins Inc.)

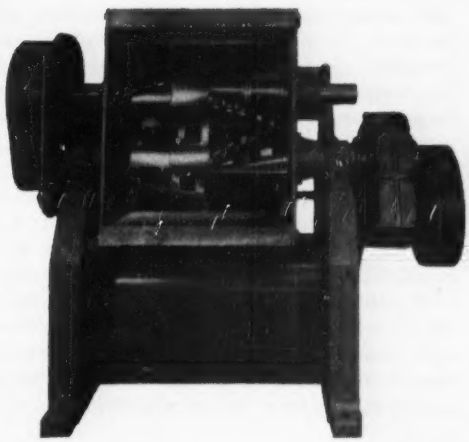


Fig. IV-4—At Right: Bramley-Beken type kneader-mixer in tilted position, uses paddles which overlap as in Fig. IV-1b. Fast blade has twice the speed of the slow blade, thus squeezing material between the blades. (Bramley Machine Co.)

IV—Plastics Mixing . . .

A kneader consists of a rectangular trough, having its bottom of two-lobe shape so as to fit the path of travel of two parallel agitator blades. The blades are mounted horizontally in bearings in the end walls.

Kneaders are used mainly for batch operations, although continuous kneader mixers have also been designed. There are two main variations in the design of batch kneaders: the so-called tangential type sketched at (*a*) in Fig. IV-1, and the overlapping-blade type sketched at (*b*). In the tangential type, which is the more common, there can be no interference of one blade with the other because their paths are substantially tangential, but do not meet. Consequently, the blades can have any relative speeds desired by the designer. In the overlapping type the blade design itself is to some extent dictated by the fact that there is overlap: the blades must always clear each other. In addition, the ratios of blade speeds are limited to whole numbers. Practically, overlapping mixers use only 1:1 and 1:2 ratios of blade speeds. The latter, found in the novel Beken mixer, is indicated in the design represented schematically in Fig. IV-1*b* (see also Fig. IV-4). The blades used in this mixer are substantially flat and paddle-like, with several mounted on the same shaft and arranged in helical pattern. The feature of the paddle design and 1:2 speed relation is that the fast blade, in overtaking the slower blade, is able to exert a powerful squeezing action on material between them. Several characteristics of the resulting motion are said to be unique among mixers of the double-arm type.

In any double-arm mixer, of the tangential or the overlapping type, the bottom outline is formed by two intersecting cylindrical arcs dimensioned for close clearance with the mixing arms. Such a mixer usually has a cover to confine dust, vapors or gases, or permit vacuum operation. Ends of the trough have suitable bearings and bearing supports for the mixing blades, and stuffing boxes to seal the blade shafts. A heating or cooling jacket is usually provided outside the trough section. Timing gears are used for phasing the mixing blades. Charging of the mixer is usually accomplished by opening the cover; and discharging either by tilting the trough or through suitable valves or gates at the bottom.

Mixers of this type may require modification to take care of specific process requirements. Some of these specific requirements would include resistance to chemical corrosion, resistance to abrasion, ability to operate at temperatures as low as −100 or as high as +700 deg. F., and suitability for pressure or vacuum operation. Mixers may have to operate in hazardous processes and in many cases must be able to develop high shear forces to handle extremely viscous materials or produce extremely fine dispersions.

A great many blade forms have been designed for double-arm mixers. With some of these, a through shaft would take up appreciable volume and possibly interfere with mixing action so it is eliminated entirely. One such blade which has only the side arms is the well-known sigma or Z form which is in extremely widespread use today. Several modifications of this form are also used, each having its particular field of application.

Fig. IV-8—Top view of Simpson Mix-Muller shows broad-faced mulling rolls and plows. A spring loading arrangement for adjusting wheel pressure, not shown here, is used in some models. (National Engineering Co.)

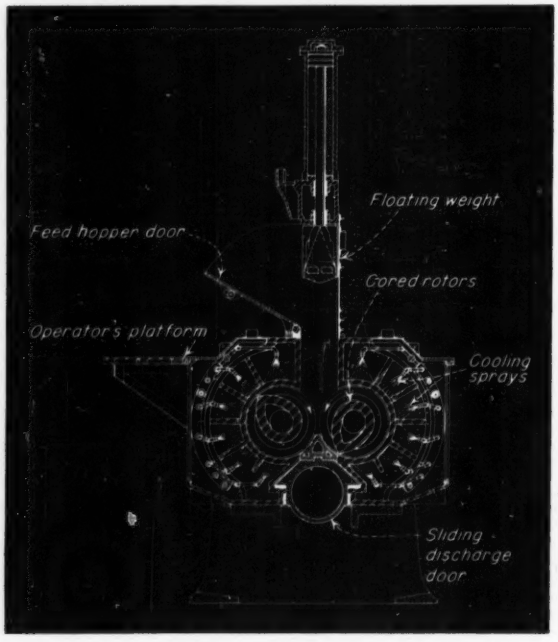


Fig. IV-6—Cross-section of a typical Banbury type internal mixer for heavy-duty fluxing and mixing of rubber and plastics. Note spray cooling. (Farrell-Birmingham Mfg. Co.)

Most of today's blade forms are similar to those developed during the last century, although they are now provided with heavier blade contours for greater power loads. Where blades need to withstand abrasion or corrosion, either replaceable wearing shoes or welded coatings of abrasion-resistant metal have been used with great success. It is possible to add considerable heat transfer area to a

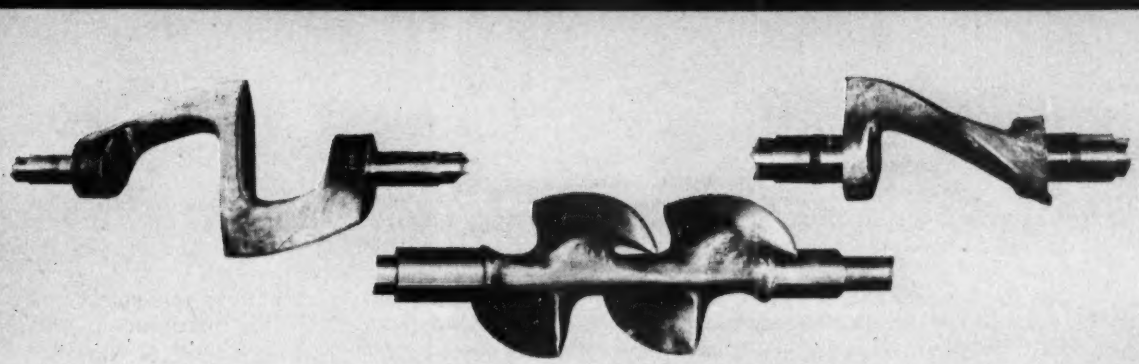


Fig. IV-5—Blades for double-arm kneaders are of many types, although most of them are variations of the three shown here. At left is the common sigma blade, made both smooth and serrated. The center blade is the Double Naben or fish-tail type. At right is one form of dispersion blade. All intensive mixer makers have their own dispersion blade designs. (Baker Perkins Inc.)

batch mixer by the simple expedient of coring the blades for flow of heating or cooling medium. This added heat transfer area is particularly effective since it is in extremely intimate contact with the mix itself.

Although the sigma or Z-shaped blade is the most common type used, there are a number of other important variations including the Double Naben, several types of dispersion blades, the Beken paddle blade and the Simplex type. This last, however, finds use only in light-duty single-arm mixers. Several of these blade types are shown in Fig. IV-5.

In the case of the sigma blade, best mixing action is obtained when the front blade revolves at a speed of about 1½ times that of the rear blade. In processes requiring development of maximum shear forces for very intimate mixing, dispersion or single-curve blades such as those shown in Fig. IV-5 are usually specified. Such blades call for large power input and very heavy construction and operate best at a 1½:1 speed ratio. Another variation, the so-called Double Naben or fish-tail type of blade, is particularly effective in drying operations and in processing certain heavy plastic type materials. These blades, too, operate best at a speed ratio of about 1½:1.

Selection or design of a kneader properly starts in the pilot laboratory because any attempt to predict all of the design factors from a description of the materials to be mixed, and of the product, will certainly lead to error. The problem of matching blade design and speed, volume to be mixed, mixing time and blade action is a difficult one, which unfortunately cannot be correlated readily with performance of extremely small laboratory batch mixers. Blade design alone is an involved problem, with type, pitch and twist to be reckoned with. Hence, blades are made in a great number of minor variations. This is particularly true of the sigma type.

In some types of kneader it is possible to use a ram which is lowered into the upper part of the mixer trough during operation to confine the material being mixed to the active zone. Sometimes such an arrangement is beneficial, but in other cases it may be wasteful of power through its additional frictional surface and compression of the batch.

In operating kneaders it is generally best practice to employ the highest plastic viscosity within the mechanical limits of the machine and the properties of the mixture. At high plastic viscosities, exchange of the mix from one blade to the other is facilitated and the maximum amount of work is done on the charge. Actual quantities loaded into the mixer are sometimes critical. Too small a charge may pack the mix on the blades without interchange, whereas too large a charge may cause some of the material to ride above the rotating blades.

Internal Mixers

The internal type mixer, as typified by the Banbury and some intensive mixers, resembles a kneader in a general way but is able to apply much more power per gallon of working volume. The Banbury (Figs. IV-6 and IV-7) has two adjoining cylindrical sections which meet tangentially to form an enclosed mixing chamber, with a ridge or "saddle" at their lower juncture. In each cylinder is a blade or rotor which is pear-shaped in cross-section and roughly spiral along its length, the two resembling intermeshing screws. These revolve toward each other at the same speed. Commonly used speeds are 20, 30 or 40 rpm. in a single-speed machine. Rotors are cored to take either steam or cold water, while the chamber may be externally water-sprayed, or it too may be cored. An air-operated weight or ram in the feeding neck holds the stock in the mixing chamber. Confinement of the stock and close clearance both work to produce an intensely powerful mixing action. This action takes place between the rotors, the ridge, and the surface of the chamber.

Like kneaders, internal mixers can be discharged by tilting the mixing vessel, or by uncovering an opening in the bottom. The Banbury, which is the most commonly used internal mixer, has a sliding discharge door of extremely heavy construction built into the ridge between the two lobes in the bottom. Most other types can be secured in the tilt-to-discharge type.

In a typical rubber mixing application of the Banbury, involving a batch of 150 lb., the stock is fed into the chamber, the ram is lowered, and pressure is applied. Mastication is carried on for about 3 min., after which the ram is raised and the accelerators, antioxidants and softeners are added. As soon as these are well dispersed the ram is again raised and half of the total fillers is added. Then the ram is gradually lowered and allowed to float on the mass for 1 min., after which pressure is applied. When the fillers have been taken up by the rubber the ram is again raised, the remaining fillers added, and the ram again is lowered and pressure applied. When the second load of fillers has been taken up the stock is discharged through the bottom outlet to an open two-roll

mixer which sheets it crudely. Overall time in the internal mixer is about 10 min.

Compared with mixing rolls (see below), an internal mixer gives the desired degree of mastication much more rapidly, produces a more uniformly mixed stock, and effects considerable savings in power. Larger quantities of material can be handled at a single time, thus rendering control of the mixing easier. An outstanding feature is that many materials which are exceedingly unpleasant to handle on open mixing rolls—for example, carbon black—are confined to the mixing chamber and prevented from spreading.

The Muller Family

The muller or edge runner mixer shown in Fig. IV-8 is a very old type of mill consisting of one or two thick circular wheels or rollers of stone or cast iron which roll about a vertical shaft on a circular flat surface. The wide face of the roll performs a mashing and smearing action on the material being mixed or ground, similar in many respects to that of a spatula smearing a paste on a flat surface—or a pestle grinding a powder in a mortar. This action is termed "mulling," and it differs from that obtained in other mixing machines. The smearing action comes from the fact that there is a certain amount of skidding of the grinding face of the roll on the flat surface. Scrapers and plows control the movement of material being mixed by returning it into the path of each roll.

Mills of this type are made in a number of variations and go under several different names. One name is "putty chaser." In the form known as the edge runner the grinding floor or pan remains stationary and the vertical shaft revolves. If the pan revolves while the roll shaft remains in one position, we have the pan mill, or dry pan, commonly used in the clay working industry. A similar modification used in chocolate manufacture is the melangeur. All of these mills are equipped with very heavy rolls for simultaneously grinding and mixing.

Still another modification, the Lancaster mixer, adds a planetary motion which corresponds roughly to the type of motion encountered in pony mixers for pastes. Modifications, of course, are introduced to take care of the differences in materials handled, since the pony works on pasty substances while the Lancaster works on mixtures from stiff plastics to dry solids. In the Lancaster the pan revolves in one direction while a mixing head carrying a combination of muller wheels and plows revolves in the opposite direction, its center offset with respect to the pan. Fig. V-15, in the next section, shows such a mixer, but with plows only where mulling action is not needed.

Mills working on the mulling principle have found extensive application in the mixing of solids in the form of powders, granules, and other particles. The Simpson Mix-Muller, widely used for such applications, is constructed with lighter muller wheels which can be adjusted for pressure on the pan by means of a spring in some later models. Thus the pressure can be adapted to the type of material being mixed. Such mixers come in pan diameters to 100 in. for working capacities up to 60 cu. ft.

One of the advantages of a muller is that the charge in the pan is not critical. Material not directly under the rolls can vary in depth, and the rolls themselves are pivoted and can ride up on top of the material. The greatest utility of the muller is in mixing pastes that have a high yield value and relatively low viscosity. The crushing effect reduces any aggregates present in the mix. Mullers are definitely advantageous compared with other mixers in processing pastes of this type. They are used in mixing compositions such as asphalt flooring, carbon electrodes,

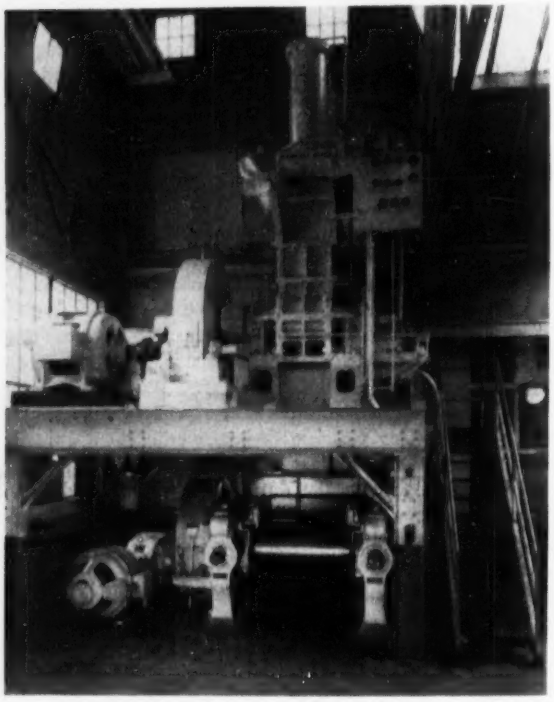


Fig. IV-7—Banbury mixers are designed to apply much power per unit volume of material. Note roll mill for sheeting below discharge. (Farrel-Birmingham Mfg. Co.)

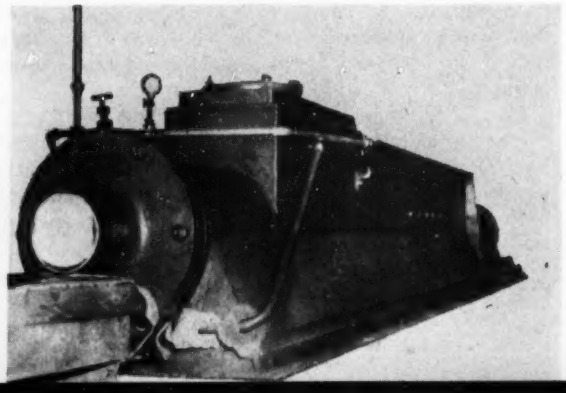


Fig. IV-11—Combining a pug mill and extruder with means for evacuation enables clay to be de-aired for a denser product, free from laminations. (International Clay Machinery Co.)

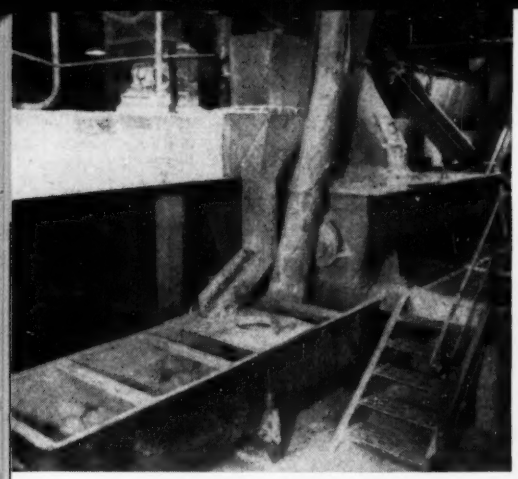


Fig. IV-10—Open type pug mills shown here are being used for continuous production of concentrated superphosphate fertilizer.

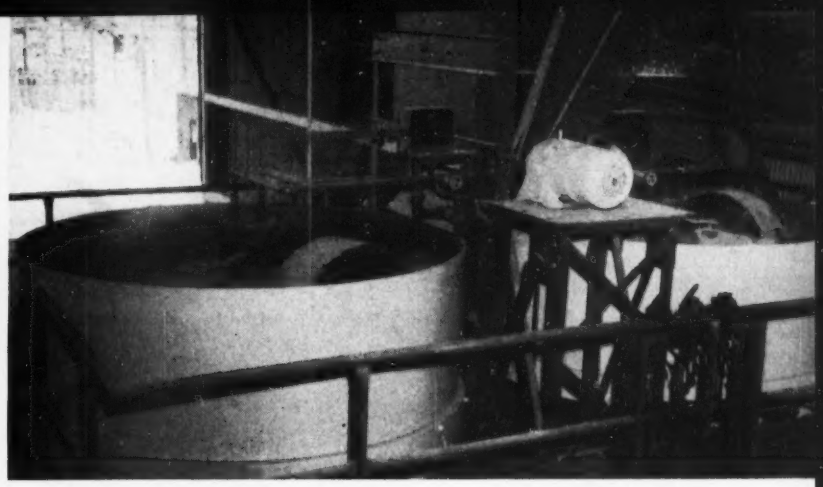


Fig. IV-9—Pair of automatically controlled Mix-Mullers in a chemical plant. Mullers find use in both plastic and dry mixing. Typical applications include cements, carbon electrodes, putties. (National Engineering Co.)

clay, crayons, luting mud, graphite products, putties, cements, soaps, storage battery pastes, welding rod coatings, and coating compositions.

Mullers are discharged by the action of the plows which scoop the material so that it falls through a door or hatch in the pan. Mixing is rapid and the cycle generally ranges from 3 to 8 min.

Pug Mills

Pug mills have long been used in the clay-working industry for blending and homogenizing clay in the initial stage. They are also used for mixing plastic solids where the breaking up of heavy agglomerates is encountered, and for preparing heavy consistency slurries. They are built in both cylindrical and double-trough styles, the first of these having one and the second having two shafts. Fig. IV-10 shows the double-trough, two-shaft type of pug mill.

The cylindrical type is also made in smaller capacities as a vertical unit.

The shaft or shafts of a pug mill carry a number of blades or knives helically arranged like the thread on a screw. As the shaft turns the knives cut the clay, mix it, and carry it forward through the vessel to be recut and mixed by each succeeding blade. A very homogeneous product can be obtained, especially if the clay mass is passed through the mill several times.

The arrangement and shape of the knives is important and varies somewhat with different types of mill. Ordinarily they are arranged in helical form so as to impart a forward motion to the clay while mixing it. Unfortunately, the two processes of propulsion and mixing are largely incompatible so that the blade arrangement is necessarily a compromise. The last blade in the mill nearest the mouthpiece is generally a complete screw since its only function is to drive the clay into the mouthpiece.

The best shape for the single-shaft type of pug mill's case or barrel is polygonal, although few are of this shape. A cylindrical case has a tendency to carry the clay around with the blades, whereas the corners of a polygonal mill prevent this. A slight taper of the case toward the discharge is also desirable as this shape is less likely to cause lamination and other defects in the clay. However, this has the objection of preventing the exchange of blades at different parts of the barrel.

Horizontal enclosed type pug mills designed for evacuation are used to agglomerate and de-air clay to increase its plasticity and gain other advantages by removing the adsorbed gas film from the particles. Fig. IV-11 shows a de-airing pug mill of this type.

With clays that require a great amount of mixing an open-type two-shaft pug mill (also called a "trough mixer") is often used. The two shafts rotate toward each other and occasionally are driven at different speeds. This type may be used as a preliminary mixer, with the clay later entering a pug mill of the ordinary closed type. The open two-shaft pug mill is used extensively as a continuous mixer for liquids and solids, for example, in making phosphate fertilizers. Fig. IV-10 shows a cascade of pug mills of this type.

For efficient operation, the speed of a pug mill should be regulated so that mixing is completed as the clay reaches the exit of the mill. If mixing is completed too soon the mill can be speeded up or the angle of a few blades decreased. If mixing is not completed in time, either the angle of several blades or the speed must be altered accordingly. Usual speeds are from 8 to 12 rpm.

Roll Mills

Mills consisting of two horizontal open rolls have long been used in mixing rubber and certain of the plastics. In operation, the plastic mass is placed in the bite between the two rolls as they rotate inwardly. As the mass is drawn into the opening between the rolls it receives a kneading and folding action. Since the rolls rotate at different speeds, the mass tends to collect on the faster front roll, where it receives a shearing and wiping action. A difference in temperature between the two rolls will cause the material to stick to the hotter roll.

In use, the operator bias-cuts through the coating on the roll and folds the sections back onto one another to promote mixing. Since the opening between rolls is adjustable, the final rolling can be any thickness.

Rolls are generally 22 to 24 in. in diameter and from 48 to 60 in. long. The front or driven roll operates at about 20 rpm., while the back or drive roll operates at about 16 rpm. This ratio of about 1¼:1 is obtained by suitable timing gears. However, the relative speed could be as high as 2:1. As with other intensive type plastic mixers, the rolls are cored for cooling water but may be heated by steam if desired.

Solids Mixing

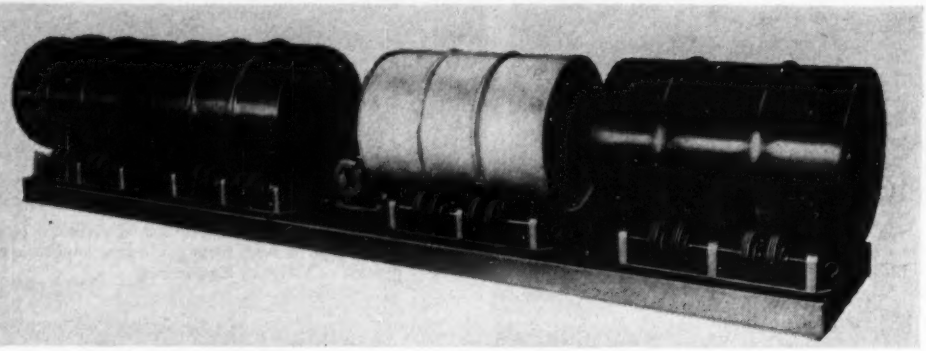


Fig. V-1—As many as four 55-gal. drums at a time can be rolled for mixing of their contents by motor-operated drum rollers. Method is not limited to solids, of course. (U. S. Stoneware Co.)

Although there is a somewhat confusing variety of machines capable of mixing dry, granular, or powdered solids, the operation itself is not difficult unless it is complicated by the tendency of some of the dry materials to agglomerate in the presence of moisture or a wetting liquid. The mixing and blending of dry solids depends primarily on the physical properties of particle size, particle size distribution, specific gravity, and particle shape.

Blending of various similar batches of dry solids is often necessary, even though the differences between batches may be minute. This is often practiced to assure correct tint, physiological assay, or taste. In addition, of course, there is the problem of bringing together a variety of ingredients to produce a uniform mixture. If the specific gravity of the ingredients is high, or their particle size is small (e.g., 325 mesh) the power consumption tends to be large, as is the time required to achieve uniformity in the batch. This is due both to the increased frictional resistance to mixing (on account of the larger surface of the smaller particles), as well as the heavier mass that must be moved.

In some cases, solids blending operations must be carried out gently, without impact action, to prevent damage to the product's particle structure. Products of this kind include crystals, tea leaves, diatomaceous earth, and the like. In such cases mixers with certain types of agitators may be undesirable, and a mixer having only gentle tumbling action may be the best solution.

Another type of problem occasionally encountered is the case where particles of widely differing specific gravities must be mixed. In extreme cases there is likely to be a subsequent tendency toward "unmixing" or segregation, due simply to minor vibrations resulting from handling, traffic, or shipment.

The basic idea involved in the mixing of dry powdered materials is the one found in the old manual method where the material is heaped on the floor or ground and then is repeatedly cut and piled by a shovel, rake or hoe. Even this elementary way, surprisingly enough, can be performed incorrectly. Therefore there are established procedures for hand mixing, for example the ASTM procedure for mixing to insure obtaining a representative sample.

Fig. V-2—Another method of mixing contents of 55-gal. drums is the end-over-end type drum mixer shown here in use as a process mixer for friable solids. (U. S. Stoneware Co.)

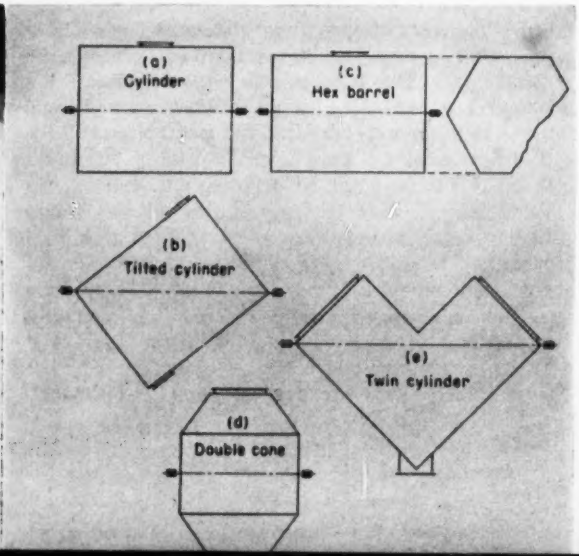


Fig. V-3—Five main types of trunnion-supported drum mixers are compared here in conjunction with Table IV on basis of floor space, weight of shell, and other factors.

Solids Mixing Equipment

Means of mechanizing the basic hand method are numerous, but in general they all come down to devices which perform various combinations of tumbling, rolling, and repeated cutting. Many of these are variations of the tumbling barrel, for example, Figs. V-1 and V-2. A drum or cask one-quarter or one-third full of material to be mixed can be rolled on the floor manually; or it can be rolled on parallel roller shafts (Fig. V-1) if the operation is to be mechanized. A drum can be provided with tires carried on wheels and driven by a girth gear as in the case of the glass-batch and concrete mixer (Figs. V-10 and V-11) or it can be carried in a number of different ways on trunnions. The trunnions can be located in the axial center of each of the drum heads, or the drum can be tilted by having the axis of the trunnions pass through opposite points on the chimes. Still another variation is to pass the trunnion shaft through the sides of the drum, parallel to the heads and midway between them. A variation of this is a machine (Fig. V-2) having a rectangular frame and saddle to which the drum can be fastened by straps and then rotated end over end. Another variation is to form the drum as a hexagonal prism. Two drums may be fastened together at approximately right angles, or an end-over-end drum can be provided with conical ends as still another variation. Fig. V-3 illustrates the five main variations of the trunnion-supported drum-type mixer.

Brown (*Ind. Eng. Chem.*, **42**, 57A, 1950) gave an analysis of these five types, pointing up the differences in cost and structural design. Table IV compares typical designs of the five types (all with the same working volume) on the basis of (1) distance between bearings, (2) floor space requirements, (3) gross weight of plate required, (4) finished weight of the mixer vessel (not including shaft, frame, or drive), and (5) quantity of welding needed to produce the vessel. The table compares these factors for the five types, taking the plain cylindrical trunnion type drum mixer as unity in each case. It is evident that the horizontal drum, Type A, the tilted drum, Type B, and the conical type, D, require less steel plate for fabrication. They are also best from the standpoint of floor space requirements. The weight advantage of type D may be important if the shell must be fabricated of expensive stainless steel. Comparing all the factors, it appears that the conical type, Type D, has the greatest advantage, a fact borne out by the wide increase in use of this type in recent years.

Table IV—Comparison of Some Trunnion Type Dry Mixers

(Type letters refer to Fig. V-3. Data are given in comparison with Type A which is expressed as 1.0. All data are based on mixers with working capacity of 50 cu. ft., made from ¼-in. plate. After C. O. Brown.)

Type	A	B	C	D	E
Bearing centerline distance	1.0	1.2	1.24	0.8	1.53
Floor space	1.0	1.23	1.39	1.13	2.32
Gross wt. of plate	1.0	1.0	1.1	0.81	1.09
Finished wt. of mixer vessel	1.0	1.01	1.09	0.77	1.01
Lin. ft. welding	1.0	1.04	1.25	1.37	1.42

Drum type mixers of the various sorts can be modified by providing interior mixing plates or baffles fixed to the inside of the drum, either parallel to or at oblique angles to the central axis. This permits lifting more material per revolution than would be possible by frictional drag of the interior wall alone.

In a horizontal drum mixer the proportions are ideal when the drum length equals the diameter. If the length is greater, there is a problem in making certain that the material against one drum head is properly admixed with material at the other end. Such mixers are charged and discharged through a port in the center of the cylindrical wall. However, if the drum is long, several openings may be necessary to decrease charging and discharging time. In this case, however, the time required for closing and opening port holes becomes appreciable with larger mixers. To obviate this, several types of horizontal drum mixer have been designed for charging and discharging while the drum is being rotated. This means either providing openings through the heads by way of hollow trunnions, (Fig. V-12), or eliminating the trunnions and bearing stands entirely and supporting the drum on tires and

Fig. V-4—Twin-shell blender formed of two intersecting cylinders gives a cutting and recombining action for quick mixing of powdered materials. (Patterson-Kelley Co.)

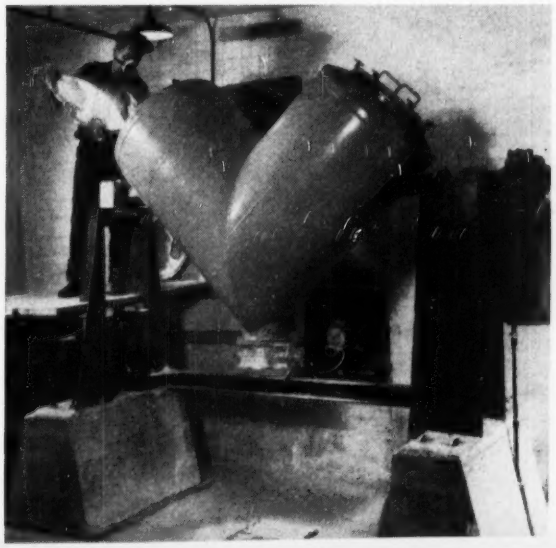
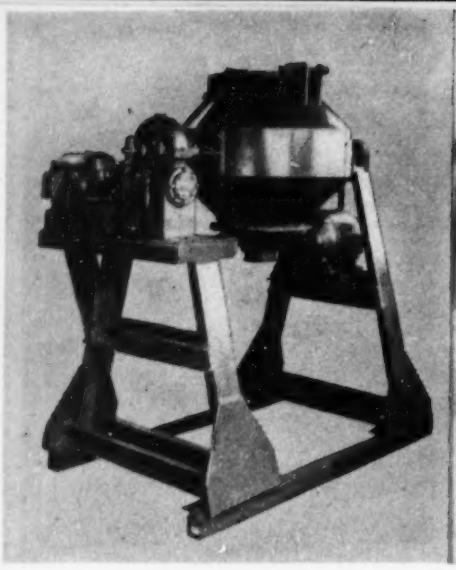


Fig. V-5—Double-cone blenders are now becoming the most popular dry solids mixer. Their action is gentle yet faster than ordinary tumbling barrels. (International Engineering Co.)



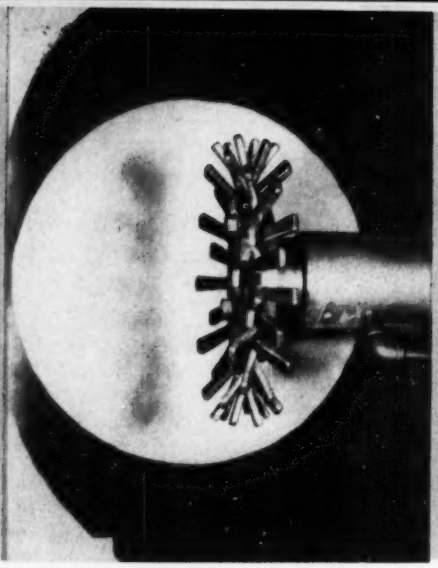


Fig. V-6a and b—Double-cone blenders are equipped with various special devices such as internal disintegrating wheels and heating jackets. Inside the Gemco blender at the left is a serrated wheel shown in detail at the right for breaking up materials which tend to ball. (General Machine Co. of N. J.)

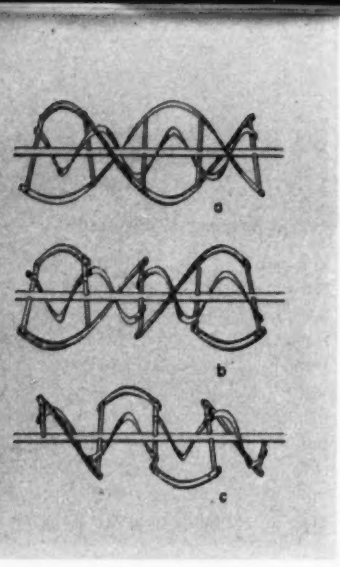


Fig. V-7—Typical ribbon agitators used in ribbon blenders. Both continuous and interrupted types are shown. (J. H. Day Co.)

rollers as in the case of the concrete mixer. Figs. V-10 and V-11 show industrial mixers of the last type. With most of these methods of emptying through the end, baffle plates must be installed to convey material toward the discharge end.

One method of overcoming some of the objections of the horizontal drum mixer is shown in Fig. V-3 *B*. Here the drum is tilted so that there is flow from end to end as the drum rotates. The discharging operation can be improved by placing the discharge port at the extreme end of the cylinder. Another method of improving the horizontal drum mixer appears at Fig. V-3 *E*. This design joins two cylinders together at approximately right angles so as to take advantage of the cutting and recombining actions produced as the mixer rotates. In effect, this design is a combination of the tilted drum plus the lower active half of the double-cone mixer.

Conical Mixers

Of the various modifications of the trunnion-supported drum-type mixer, the double-cone or conical type of Fig. V-5 has been most widely used. This mixer consists of two cones base to base (or with a short cylindrical section between their bases), with the axis of rotation through a diameter of the base. This type of mixer provides more mixing action than can be obtained by straight tumbling because of the way the material slides off the interior surface of the cone, a surface that changes continually during rotation. This produces a folding of the material upon itself and thus gives more rapid mixing than could be obtained from the simple cascading action in a horizontal cylindrical drum mixer. As in the case of the horizontal drum mixer, the flow of material is gentle and both types can be used satisfactorily on friable or fragile materials like tea leaves, seeds, and crystals. The conical mixer is also successful on powders of a wide range of particle size, or mixes involving particles differing markedly in specific gravity.

It is important in the use of a conical mixer that the moisture content of the aggregate material should not be sufficient to cause agglomeration by adhesion. In general, cascading action mixers should be used only for dry materials, since they tend to produce "balling" with damp materials. However, cases do arise where it is desirable to

Table V—Typical Conical Blenders

(Working capacity based on 65 per cent of actual volume)

Working Capacity, Cu. Ft.	Diam., Inches	Horsepower for Material Weighing Lb. per Cu. Ft. 0–50	51–75	76–100	101–125	Speed, Rpm.
1.0	18	¼	¼	¼	½	30
2.3	24	¼	½	½	¾	25
4.7	30	½	½	¾	1	20
7.8	36	½	¾	1	1½	20
12.0	42	¾	1	2	3	16½
18.6	48	1	1½	2	3	16½
27	54	1½	2	3	5	16½
37.2	60	2	3	5	7½	14
46.2	66	3	5	7½	10	13
62	72	5	7½	10	15	13
102	84	10	15	20	25	10
152	96	15	20	25	30	10
217	108	20	30	40	50	9
300	120	30	50	60	75	9

Fig. V-8—A ribbon mixer is one of the most versatile of all mixers, being suitable for dry solids, for mixing solids with liquids, and even for mixing liquids or suspensions.

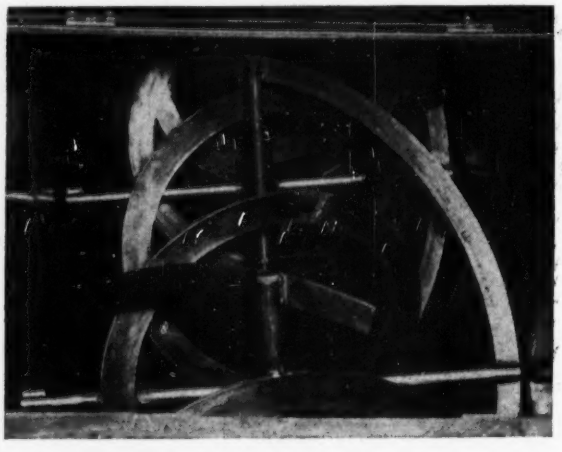


Table VI—Typical Ribbon Mixers

Working Capacity, Cu. Ft.	Vessel Size, Inches, Width × Height × Length	Hp. for Material Weighing Lb. per Cu. Ft. 0-30	31-50	51-75	Ribbon Speed, Rpm.
50	18×22×40	1½	2	3	53
75	18×22×60	2	3	5	53
100	24×30×45	3	5	5	40
125	24×30×56	3	5	7½	40
150	24×30×68	3	5	7½	40
175	30×36×51	3	7½	10	32
200	30×36×57	5	7½	10	32
250	36×42×50	5	7½	10	27
300	36×42×60	5	10	15	27
350	36×42×70	5	10	15	27
400	42×48×59	7½	10	15	23
450	42×48×66	7½	10	15	23
500	42×48×73	10	15	20	23
600	42×48×88	10	15	20	23
700	48×54×78	10	15	20	20
800	48×54×90	10	15	20	20
900	48×54×101	15	20	25	20
1,000	54×60×89	15	20	25	18
1,250	54×60×110	20	20	25	18
1,500	60×66×108	25	25	30	16

add a small amount of liquid to the solids in the mixer. With mixers rotating on trunnions, a pipe can be run through a rotary joint in one trunnion for injection of the liquid by aid of a spray pipe.

A method used by several conical mixer manufacturers to break up agglomerates is to mount some kind of disintegrator wheel inside the mixer on the central axis. Ordinarily, this is operated by a rotating shaft through the trunnion opposite to that of the driving mechanism. One variation of this idea is illustrated in Fig. V-6*a* and *b*. Here the high-speed serrated wheel breaks up any lumps or balls caused by moist materials. The power to drive such disintegrating wheels may be considerable, owing to the high frictional resistance of the solids. Such wheels may act as pulverizers of the impact type. In another variation the wheel is provided with scoops and works as an attrition grinder.

Conical mixers which require heating or cooling can be provided with steam or water jackets, with the inlet and discharge piping passing through a trunnion by means of a rotary pipe joint. If desired, the shell can be electrically heated, with surface heating units connected to the electrical supply through commutator rings attached to one of the trunnions. Dimensions and power requirements for some typical conical mixers are given in Table V.

Several types of mixer for dry solids feature use of a horizontal, generally semi-cylindrical trough in which one or more agitating devices rotate. Among these are the ribbon, conveyor screw and pug mill types.

Ribbon Mixers

Probably the most widely used solids mixer is the ribbon type which consists of a trough with a semi-cylindrical bottom, closed at each end with a flat head. Table VI gives dimensions and power requirements for typical mixers of this type. The agitator is made in several modifications, three of which are shown in Fig. V-7. Fig V-8 shows a mixer with an uninterrupted helix. Essentially, a ribbon agitator consists of metal strips bent to form a

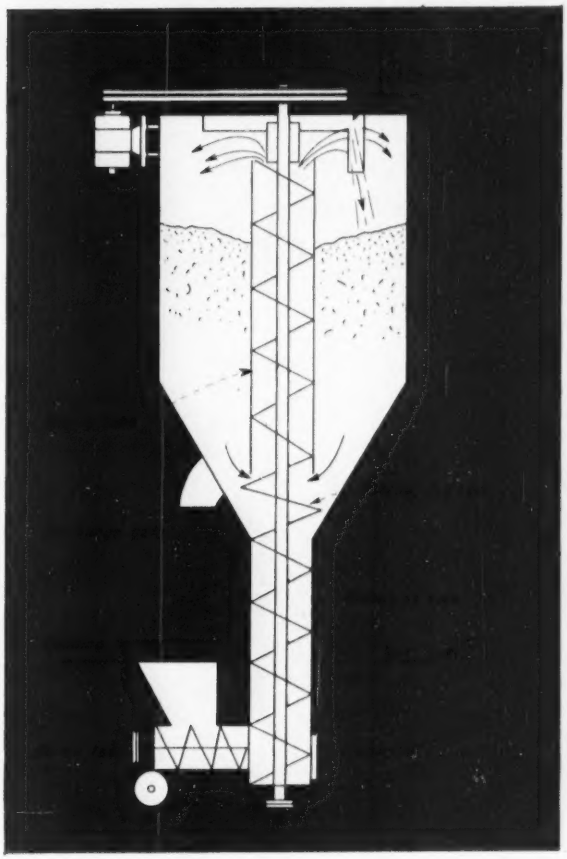
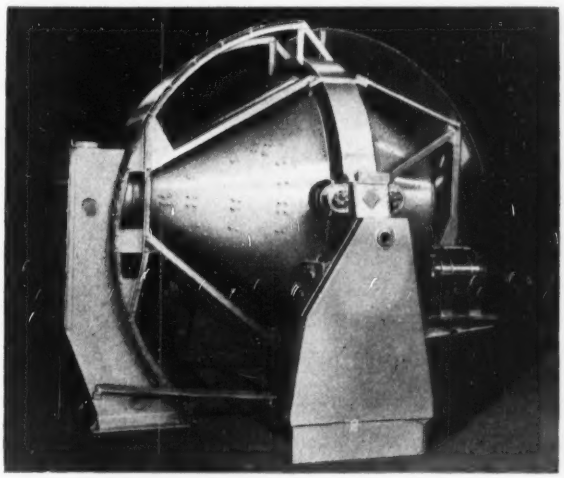


Fig. V-9—Vertamix vertical screw mixer finds wide use for mixing grains in animal and poultry feed industries. The batch recirculates until mixed. (Sprout, Waldron & Co.)

Fig. V-10—Conical tilting mixer for glass batch and other dry mixing seals dust tight, rotates on girth ring, and tilts for discharging. Capacities range to over 100 cu. ft. (T. L. Smith Co.)



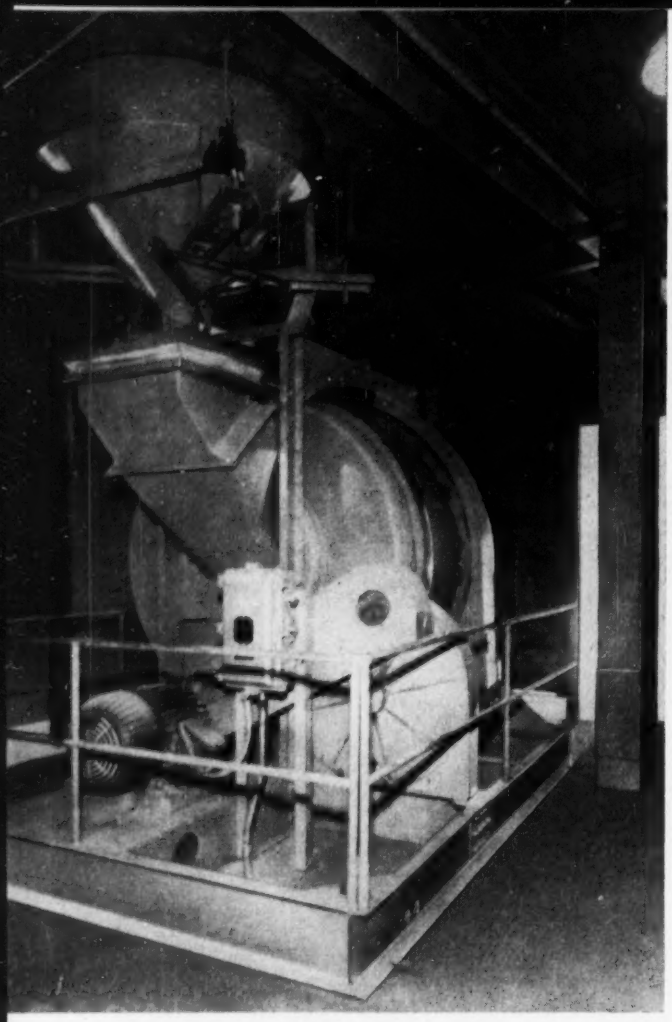
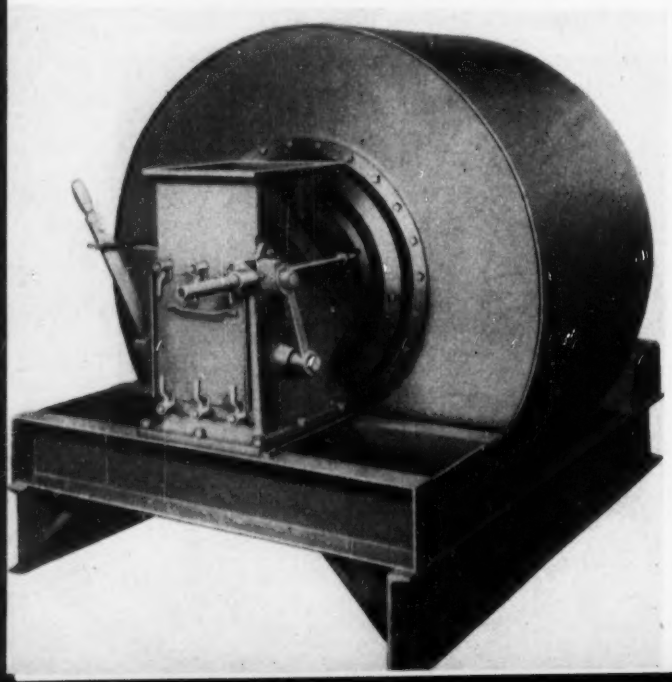


Fig. V-11—Industrial batch mixers based on the principle of the concrete mixer are used for both dry mixing and mixing of solids with liquids. (Ransome Div., Worthington Corp.)

Fig. V-12—Still another type of drum mixer has the drum carried on trunnions, with feed and discharge through a hollow trunnion on the near side. (Sturtevant Mill Co.)



spiral helix, or one helix within another. The helix will transport solid material in the direction of its throw. Therefore, to avoid piling up at one end it is customary to use another concentric helix of smaller diameter to recirculate the material in the opposite direction. The material is pushed and also displaced outward by centrifugal force. It is not, as might be imagined, steadily conveyed from one point to another by the helix.

Ribbon mixers are often jacketed for heating or cooling and can be either open or covered. Such mixers are charged through the top at center or end, and discharged through a bottom port, either at the end or in the center. If discharge is at one end, the main spiral will be arranged to feed toward that end to facilitate discharging as rapidly as possible. See type a, Fig. V-7. If the discharge is at the center, the main mixing spiral will be broken into two separate spirals of opposite rotation so as to feed toward the center, as in type *b*, Fig. V-7. The type c spiral is a center discharge type, interrupted to facilitate handling stiff materials.

Ribbon mixers can be used on solids that are to be wet by liquid since the mixing action does not depend entirely on free flow of the material as in the case of rotating drum mixers. The ribbon agitator assists in distributing small amounts of liquid and is forceful enough to do a certain amount of shearing of agglomerates. Depending on the flow characteristics of the solid when mixed with liquid, the amount of liquid added can approach a free-flowing slurry in some cases. Although not often used for that purpose, the ribbon mixer is effective also as a liquid mixer.

Other Screw Mixers

The double-spiral mixer and its modification, the pug mill, are trough-type mixers with two-lobed bottoms and parallel agitator shafts. The double-spiral type uses two agitator screws which intermesh during rotation and give a shorter mixing time than the ribbon mixer. This type is used primarily for batches of solids that are to be mixed with liquid to a pasty stage or beyond. In the pug mill modification of the double-spiral type the agitator screws are replaced by short paddle blades or knives arranged spirally like an interrupted screw on the shaft. This is the same machine described in the previous section in connection with plastic mixtures.

The screw conveyor, primarily used for moving solids, can also be used as a particulate solids mixer. Actually, the screw does not mix effectively when it simply transports material in either a horizontal or vertical direction since the material merely slides along the helicoidal surface. However, the action of the screw can be converted to a mixing action by impinging the stream of material against baffles, or by cascading. Also, the smooth flow of solids through the screw can be altered by interrupting the helicoid flight with notches cut out along its edge. The interruption to flow which results gives enough disturbance of the material to impart mixing action. Screw conveyor mixers are generally continuous and horizontal, giving a flow of material which is slug-wise and in which recycling must be used to achieve uniformity.

A type of screw mixer commonly used in the animal

Fig. V-13—The dry pan type of muller is widely used for mixing as well as grinding in the clay products industry. Here the pans rotate, while wheel shafts are stationary. This large installation is used in mixing ingredients for refractories.

Fig. V-14—Differing from the pan mixers shown above, this type used for both wet and dry mixing has a stationary pan.

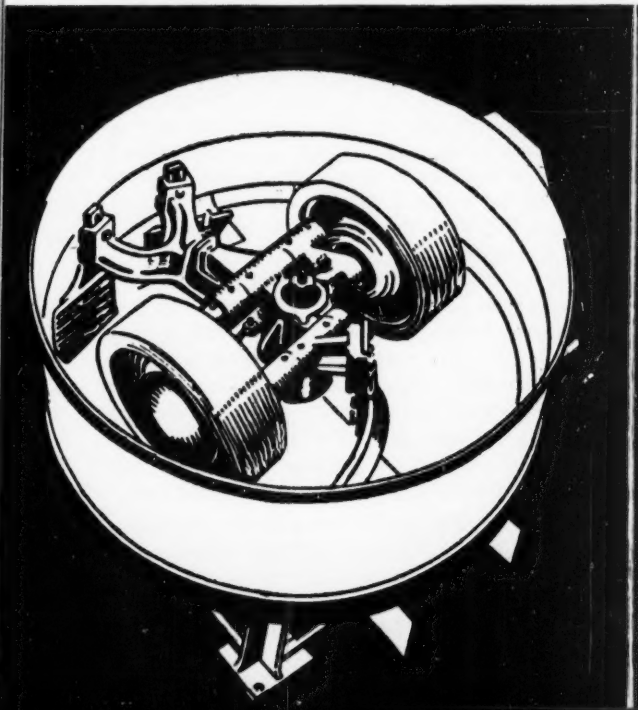
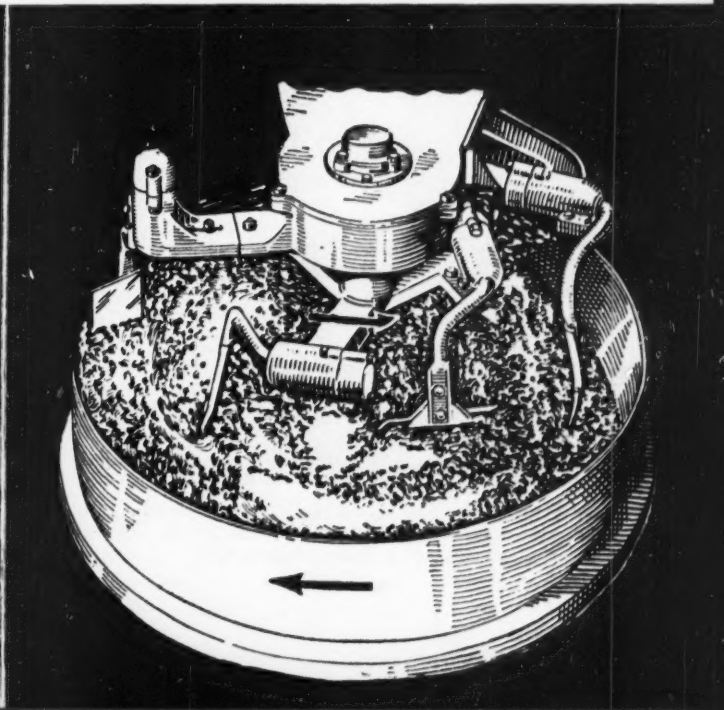


Fig. V-15—Still another pan mixer type is the Lancaster which has planetary action. (Posey Iron Works)



and poultry feed industries is shown in Fig. V-9. This is the vertical screw and hopper type sometimes called a geyser mixer. The lower part of the single vertical screw is used for introducing stock into the mixer. The upper part, running in the mixing tube, carries the material to the top and there distributes it by centrifugal force, aided by a flinger-bar which is attached to the screw shaft. A slotted baffle-plate ring of heavy construction welded to the under side of the top deck permits part of the material to pass through, but deflects other portions of the material to aid the mixing action. Unloading is from the bottom part of the conical hopper.

Mixers of this type are simple to load and unload, of light construction and of low power requirement. They give excellent results on light granular, easily flowing materials. With grains or other granular solids which do not cake when wetted, they may be used to moisten the material with liquid during mixing.

Rotary Barrel Mixers

Where large batches of dry materials are to be mixed, either with or without the addition of liquid, mixers of the rotary barrel type are commonly used because of the ease with which they can be constructed to large size and for large capacities. Such mixers can handle several tons of material in a single batch. In large sizes they may handle up to 75 or more tons per hour. Mixers of this type were first used for concrete, but are now widely used in the fertilizer, glass, refractory, foundry and other industries. The construction is similar to that of a rotary kiln, in that the drum is supported on girth tires carried on rollers. A girth gear is provided for driving. This construction permits charging and discharging through the center of the ends of the barrel. Even with the charging and discharging ports open, the barrel will hold liquid up to the level of the port circles. Therefore, this type of mixer can handle very fluid slushes and slurries, in addition to dry mixes.

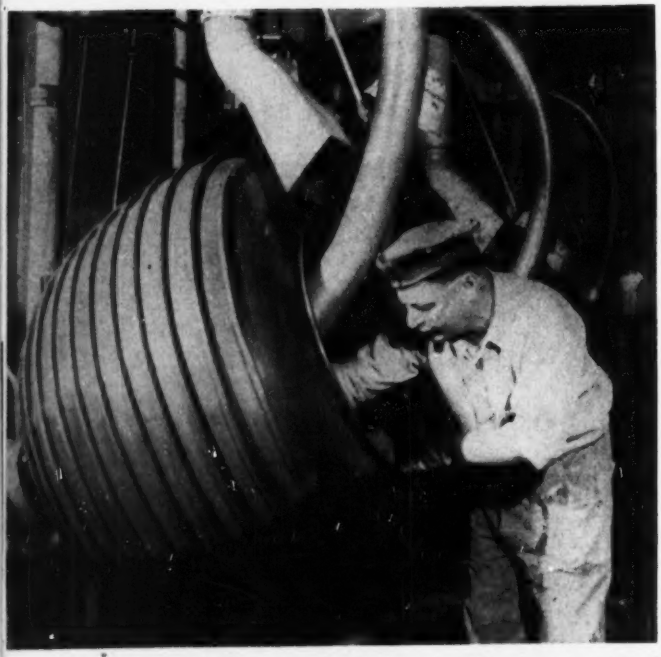


Fig. V-16—Coating pan, shown here in a pharmaceutical plant, is used for coating pills and candies but, built heavier, can also be used as a ball mill. (F. J. Stokes Machine Co.)

Tilting Barrel Mixers

One method of constructing barrel type mixers is illustrated in the unique tilting type, of Fig. V-10. Here the mixer is discharged by tilting as it rotates. The tilt is pneumatically controlled and the discharge is equipped with a sealing ring for dustless operation.

More commonly barrel mixers are provided with mixing blades attached to the inner surface of the drum which lift material and drop it as the drum revolves. Fig. V-11 is an example. For discharging, a chute is swung into the center of the drum through one opening to catch the material as it falls. The material is assisted toward the discharge side of the drum by the arrangement of the mixing blades. Another variation is to support the barrel on trunnions, one being hollow for feed and discharge. The mixer in Fig. V-12 is of this type.

Such mixers can be provided with dust-proof housings and furnished for either fully automatic or semi-automatic operation. They are made in a wide range of drum sizes, up to more than 100 cu. ft. capacity.

Pan Mixers

Mixers of the dry-pan and muller types, as in Figs. V-13 and V-14, have already been discussed in Section IV under plastic mixers. These are also used extensively in the mixing of powders and granular solids. However, for dry mixing there is a further modification of this type which can use plows alone, without mulling wheels. One type of Lancaster mixer, shown in Fig. V-15, is of this type. Both the plows and the pan rotate in this mixer. Discharging is not quite as simple with a rotating pan as in mixers with a stationary pan where a large hinged door can be fitted into the bottom of the pan and operated by a lever. Also in the dry pan of Fig. V-13, the pan rotates, but the shaft for the rollers is stationary.

One interesting application for pan type mixers in the solids mixing field is where a large grain sized material must be properly coated with material of greater density or smaller grain size. A somewhat different application is found in the animal feed industry where mullers are used for blending minute quantities of vitamin concentrates into relatively large quantities of feed.

Mushroom Mixers

A highly specialized mixing unit known as the mushroom mixer, coating pan, or "sweetie barrel" is used mainly

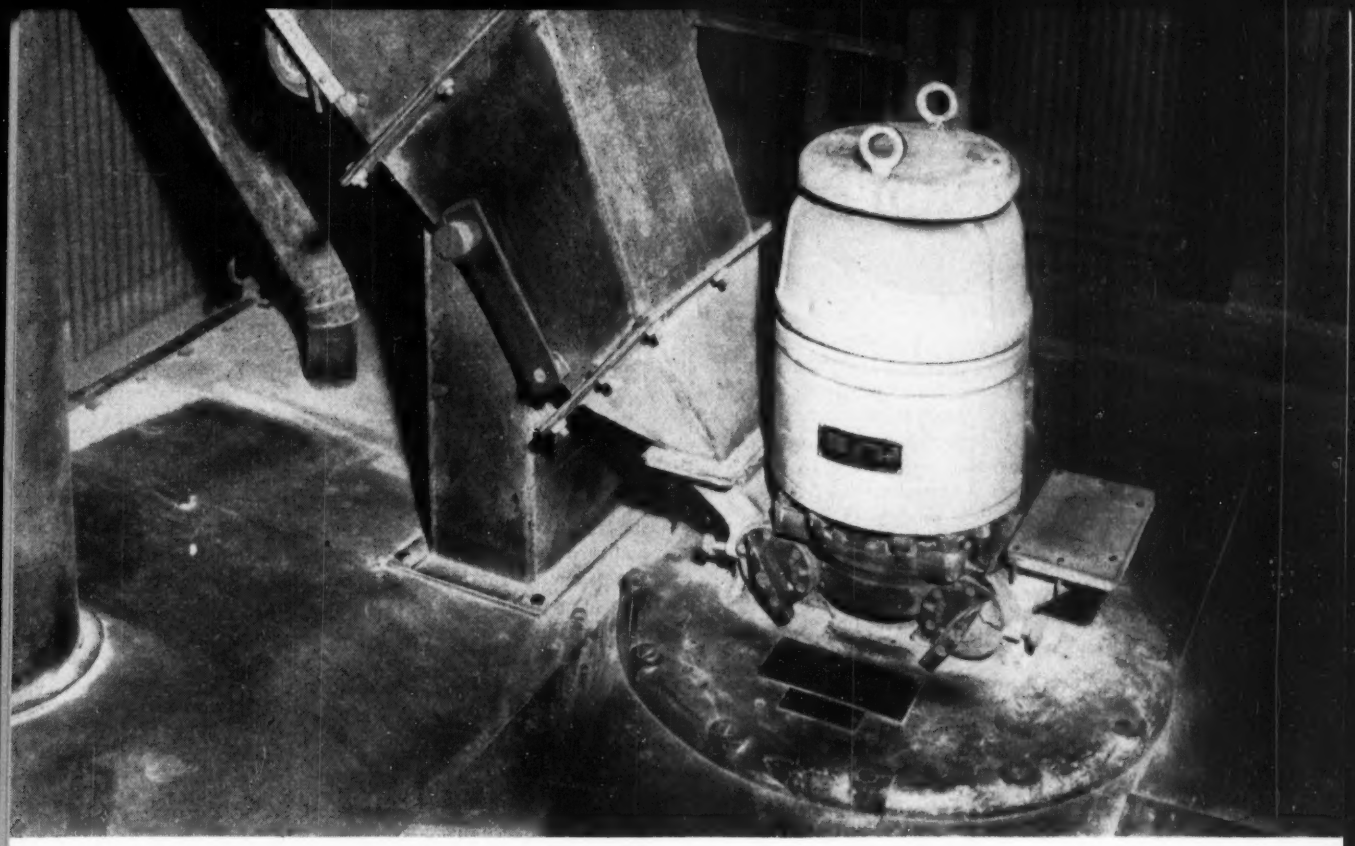


Fig. V-17—Impact mixers for solids have been gaining in recent years for blending molding powders, pigments, and the like. Here is an installation of the Entoleter (Safety Car Heating & Lighting Co.), shown below in diagram.

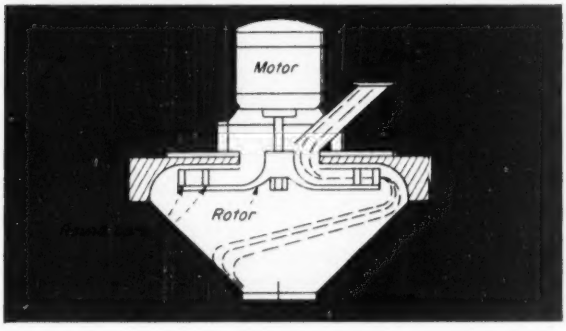


Fig. V-18—Entoleter type impact mixer has a high-speed wheel formed of disks separated by impact bars. Particles thrown outward cascade into a conical receiver. Capacities are high.

in such industries as pharmaceutical and confectionery industries for coating and polishing pills, tablets, candy coated chewing gum, and candy. Fig. V-16 illustrates a type commonly used in pharmaceuticals. If its bowl is made of cast iron or steel, several large steel balls can be added and the mill can also act as a grinder. The rotating bowl is ordinarily held at a fixed angle on the end of an inclined shaft set at approximately 60 deg. with the horizontal. In one recent design the shaft can be motor-tilted through an arc of 135 deg. for easy discharging. The pan is ordinarily rotated at a constant speed in the range from 10 to 25 rpm., although a variable speed drive can be used if needed. Such machines are built in sizes up to 3,000 lb. working capacity.

Impact Wheel Mixers

Several types of solids mixers utilize an impact wheel to throw the solids outward by centrifugal force. In machines of this type the material is fed axially on to a rapidly rotating disk or wheel fitted with breaker bars spaced around the circumference. As the material is flung by centrifugal force through these bars, it is pulverized by the impact of any large agglomerates. The particles are then caught by an annular ring and cascaded to a cone-shaped receiver which serves to mix the material additionally. The best known mixer of this type in the United States is the Entoleter illustrated in Figs. V-17 and V-18. A type known as the Pulver blender which is made in England is rather similar in its use of a high-speed wheel to throw the material outward. In addition, it incorporates a screen around the impeller which helps to break up agglomerates and serves to separate and recycle oversize.

Until recently the Entoleter was made only in sizes covering the range from 2,500 to 16,000 lb. per hr., utilizing from 2 to 10 hp., and operated at 3,500 rpm. Maximum rotor diameter was 16 in. A new model recently introduced for large throughput uses a 27-in. diameter rotor and speeds up to 4,000 rpm., giving a peripheral speed of 28,000 fpm., and capacities up to 50,000 lb. per hr. This machine may use as much as 40 hp.

These machines are used for both batch and continuous mixing and blending of such materials as plastic molding powders, pigments, insecticides, water paints, and prepared foods.

Continuous Mixing

In line with a well defined trend toward continuous production, some people are thinking in terms of continuous mixing or agitation. Previously, mixing has been done almost universally on a batch-wise basis. However, where economic factors are favorable continuous mixing is receiving increasing technological consideration.

It is well first to compare relative advantages and disadvantages of batch and continuous mixing. By comparatively simple means ingredients can be proportioned with as much accuracy as needed in batch-wise mixing. In any single batch it is necessary only to put in the specified amounts of material and continue mixing until desired homogeneity is reached.

Batch-wise mixing is the accepted method for pilot plant and laboratory experimentation; it is preferred over continuous mixing because of its adaptability under changing requirements. Batch mixing does consume, however, more space, time, and manual labor than does continuous mixing.

It is obvious that continuous mixing usually fits in better with normal factory practice. Because the continuous mixer takes substances from one process step and transfers them into the next processing stage, it eliminates temporary storage and the time and labor-consuming operations thereby required. Also, frequent start-up and shutoff of machines, entailed in batch-wise mixing, are avoided.

Continuous mixing demands continuous allotment or proportioning of the substances to be mixed. Two different methods are used for proportioning, which, in turn, characterize the two distinct types of continuous flow.

In the first, called "streamline," each of the substances is delivered as a steady flow and these separate streams are joined in one unified stream, as in Fig. VI-1. At any cross-section of the unified or total stream substances are present in the intended mixing proportions. This can be demonstrated by sampling.

For the second method, each component is fed as a slug, repetitively. During one established period of time if all the slugs of the different components are mixed together they give the desired mixture composition. These periodic portions line up in "slug-wise" manner as in Fig. VI-1.

This method requires at least one full period (sufficient time for delivery of each component in formula proportions) be subjected to proper mixing: otherwise a uniform mixture cannot be expected. If a number of periods can be mixed at one time there will be homogeneity in the final product. For correct mixing, a sufficiently large volume should be taken so that a number of slugs are received and mixed simultaneously.

Proportioning in uniform streams to obtain the "streamlined" condition is generally more worth while, but in many cases it is easier to overcome obstacles through use of "slug-wise" periodic proportioning. It is seen that the latter method can easily be adapted to changing requirements; it is necessary only to change the individual batch composition. In "streamline" proportioning a formula change or change in total composition requires adjustment of each individual proportioning device.

Continuous Mixing Classifications

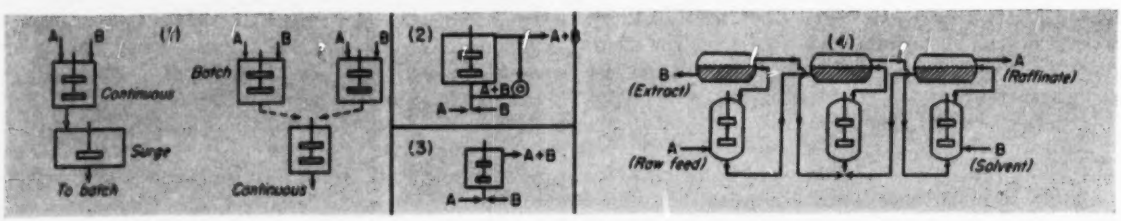
The operation of continuous mixing has received attention from a number of investigators. One group of investigators (Brothman, A., Wollan, G. N., and Feldman, S. M., *Chemical Engineering*, **52**, No. 5, 1945) has classified continuous mixing into two types: single pass, plug flow, displacement or streamlined; and multi-pass, nonstreamlined or pseudo-continuous.

Single-pass mixing applies to all continuous mixers and reactors where all portions of the effluent have remained in the system for the same time. There has been no recirculation within the system. Multi-pass continuous mixing designates a condition where material recirculates within the equipment; various portions of effluent have remained in the system for varying lengths of time.

Still another team of investigators (Olsen J. F., and Lyons, E. J., *Chemical Engineering*, **52**, No. 5, 1945) bases classification of continuous mixing on the material flow diagram. Four categories given are batch-continuous, recycle, concurrent, and countercurrent operation.

Batch-continuous system, Fig. VI-2-1 has an intermittent flow pattern during some part of the process. Actually, product from this system may flow in a continuous uniform stream. A recycle system, Fig. VI-2-2, consists of a mixing vessel with a closed external circuit. Material is continuously recirculated through this circuit. A small portion of raw material is fed continually into the

Fig. VI-2—Major categories of continuous mixing systems; from l. to r. (1) two examples of batch-continuous systems, the first using a surge tank between continuous mixer and batch process and the second using alternating batch units ahead of a continuous unit; (2) a recycle system; (3) a concurrent system and (4) a countercurrent system.



system and an equivalent portion is bled from the external circuit. Concurrent, Fig. VI-2-3, and countercurrent, Fig. VI-2-4, process are "once-through" operations with the material progressing in sequence through the equipment to the next process step.

The same team of investigators (Olsen and Lyons) give an excellent summary of continuous mixing and classify equipment arrangements according to the above grouping. In addition, they have classified mixing devices into the natural groupings based on physical state.

Batch-Continuous Mixing Systems

1. Continuous mixing step followed by a surge or storage reservoir for subsequent batch treatment.
2. Two or more batch units scheduled with staggered operating cycles to provide a continuous feed, direct or through a surge reservoir, to subsequent steps.

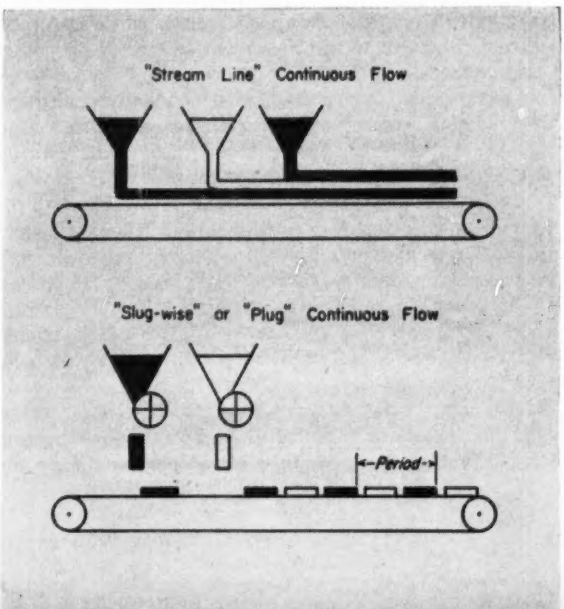
Recycle Systems

1. Gas or vapor-liquid systems using baffled, packed, spray, orifice, or bubble-cap columns.
2. Gas systems using fixed beds of solid catalyst.
3. Gas systems using recycling fluidized particulate solid catalyst.
4. Liquid-solid and liquid-liquid recirculation systems of either the separating or non-separating type.
5. Particulate solid recirculation systems using air as the circulating medium.

Concurrent Systems

1. Orifice-plate pipe line mixing.
2. Continuous flow liquid mixing vessel.
3. Continuous flow liquid mixing vessels in series.
4. Baffle plate column or packed tower.
5. Agitated gas absorber vessels in series.

Fig. VI-1—Streamline proportioning delivers continuous flow always as constant proportion of total; (b) slugwise delivery requires complete period for correct proportion.



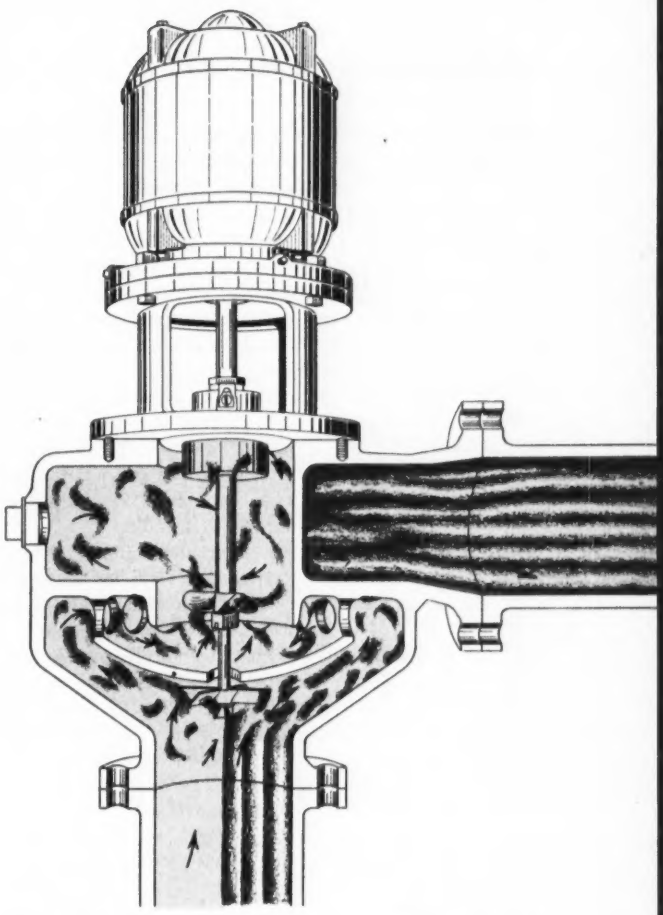


Fig. VI-3—Flomix in pipeline splits, reverses, recombines and mechanically mixes flow to intimately contact materials and produce even mixture. (New England Tank & Tower Co.)

6. Rotary kiln type of mixer for mixing solids.
7. Ribbon trough mixer.

Countercurrent Systems

1. Tower with bubble caps, Raschig rings, Berl Saddles, etc. for gas-liquid reactions; or perforated plates, baffles, nozzles, or packing for liquid-liquid reactions.
2. Mechanical absorbers for gas-liquid reaction in series.
3. Rotary kilns.
4. Vertical rotary hearth furnaces.
5. Vertical reactors for fluidized solids.
6. Dorr C.C.D. flow systems.
7. Vertical or inclined screw solvent extractors.
8. Multi-deck rake classifiers.
9. Series of individual mixers in combination with separation chambers.
10. Mixing stages combined in single vertical vessel, connected to separation compartments in adjacent vertical vessel.

Proportioning

Distribution or proportioning in continuous streams is done by commonly available volumetric or gravimetric

devices. Direct, positive displacement devices frequently are termed feeders. Some may be hand set at definite flow rates while others are actuated by controllers.

Gravimetric proportioning is subject only to the accuracy of the particular weighing device. On the other hand, volumetric proportioning may have considerable possibility of error. In volumetric measurement of gaseous materials sources of error come from changes of pressure and temperature. These can be avoided by working with the same constant temperature and pressure at all times.

With liquids, temperature and pressure are of less significance, but still they must be kept constant. A more serious cause of error is liquid holdup or adherence of liquid to the walls of the measuring device. It is possible to compensate for holdup by calibrating the device to determine the constant value for this holdup.

Proportioning of granular, crystalline and powdered solids is quite subject to error because voids between particles change in size. The ratio of void to total volume space is influenced by particle size, surface condition, particle shape, method of feeding (by sprinkling, shaking, extrusion, conveying), and size of measuring space.

Influence of variables can be minimzied by always handling any given substance in the same state through the same devices by a standardized method.

Proportioning feeders used for pasty or plastic materials are less accurate than those employed for fluids or dry solids. To avoid inaccuracies and inconsistency, it is often prudent to proportion accurately the constituent parts going into the pasty or plastic mix. Since these constituents often are liquid or dry substances, measurement and proportioning can be done accurately.

Pipeline Mixing

Continuous mixing of low viscosity liquids can be carried out in smoothwall pipes without any auxiliary equipment. If the Reynolds number is greater than the transition region on the Fanning friction factor chart, then turbulent flow is produced to mix the liquids.

Despite this fact, plant men still install baffle and orifice plates to be certain of turbulent flow under all conceivable conditions. Although this practice has been observed at several refineries, there is a lack of experimental work to evaluate the efficiency of this method. Suitability of this method of mixing definitely is questionable and there is need for evaluation of the power consumption. A clear idea of the losses involved might indicate a more efficient mixer for the duty.

Also available on the market are specially designed orifice nozzles for this type of mixing operation. Here again the matter of mixing efficiency never has been thoroughly investigated to the best of our knowledge. It is obvious they offer appreciable frictional resistance to flow. Studies are called for to decide whether the power consumed by these devices justifies their use in place of other mixer types and methods.

Injectors or eductors find use in the continuous mixing of low viscosity liquid streams. They consist of a main pipe with a concentric inner jet nozzle, tube or orifice and an arrangement whereby a side stream is injected into the main stream and a mixing tube. The device works very well for mixing gases, gases with liquids, and liquids with liquids.

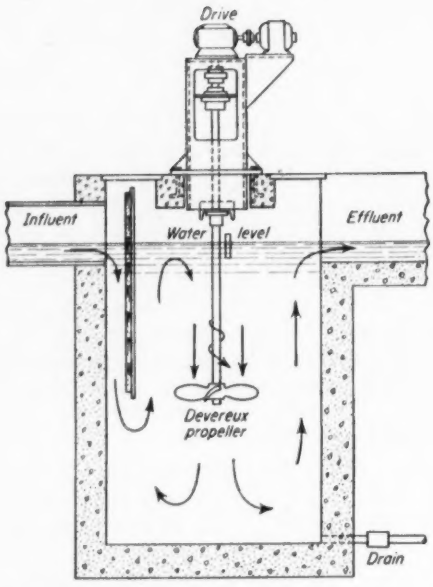


Fig. VI-4—Flash mixer provides continuous, rapid mixing of chemicals prior to flocculation. Propeller is sized to handle twice the maximum flow through tank. (Link Belt Co.)

In the majority of applications the velocity of fluid flowing in the main pipe induces a flow of material from the auxiliary pipe. However, it is possible to feed the second fluid through the auxiliary pipe under sufficient pressure and velocity to cause flow in the main pipe.

The Nettco Flomix designed as a pipeline mixer for liquids is shown in cross section, Fig. VI-3. The incoming stream contacts a turbine agitator for the first mixing, then splits in passing through a number of orifices into the inner chamber. As these streams recombine the liquid is agitated once more by the propeller. Flow reverses again in passing through baffling at the outlet.

Typical of the liquid contacting work done by the Flomix is caustic washing and oil blending in petroleum refining. On the caustic washing process over a period of many months this unit has shown an average efficiency of 64 percent compared to the 50 percent average of previously used methods.

Good pipeline mixing can be obtained with a centrifugal pump either with or without a diffuser ring. This type pump incorporates an intense mixing zone along with its inherent displacement capacity. In effect, it provides cheap mixing incidental to the pumping work.

The impeller zone is in a highly turbulent state. Changes in flow direction are drastic from pump inlet through impeller channel to volute and discharge nozzle. Retention time of less than a second may be too short for extraction work. There is no doubt, however, that for immiscible liquids the turbulence would be sufficient for complete mixing.

A number of other devices, similar to centrifugal pumps and the Flomix unit, are available for continuous mixing in pipelines. Essentially, they are all constructed on the

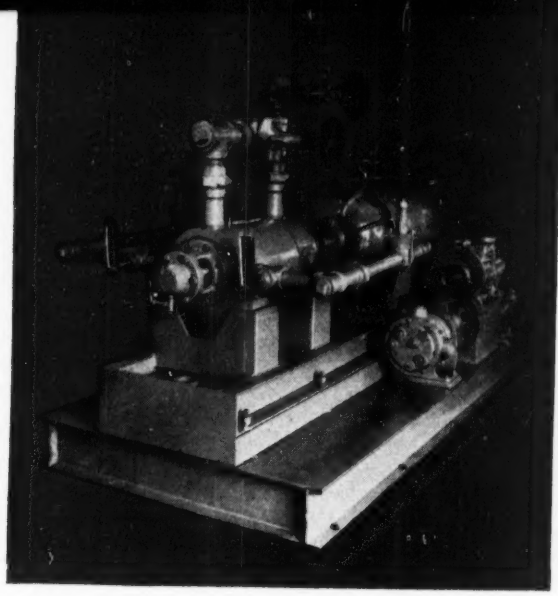


Fig. VI-5—Continuous Dispersall completely disperses or emulsifies without depending upon close operating clearances and adjustments. (U. S. Stoneware)

impeller principle. They are similar to centrifugal pumps with the exception that they are not designed for displacement or pumping of the liquid.

Although designed primarily for batch duty, colloid mills can be used as continuous mixers for the preparation of emulsions and other dispersions. The intensely turbulent zone at the impeller mixes and disperses.

Retention Mixers

Continuous mixing of liquid streams flowing in slug-wise fashion often is handled by use of a retention tank to insure complete "evening" or averaging of product composition. For simple blending of two or more thoroughly miscible, low-viscosity liquids, mixing is done instantaneously under turbulent conditions created by propeller, turbine or paddle agitators. Time of retention commonly is controlled to permit tank contents to be turned over at least twice.

When crystals are dissolved the time to effect solution must be considered; and for suspensions of solids a higher degree of agitation, in terms of high Reynolds numbers, must be employed. In general, the retention period within a mixing chamber or vessel must be sufficient to allow the desired reaction or physical change to take place.

A very common application of the retention period mixer, Fig. VI-4, is in large-scale water-treating processes for municipalities; or in addition of chemicals to sewage or industrial wastes. Chemicals are added to the liquid flow in a tank called a "flash" mixer. After thorough mixing the liquid flows through a large tank where it is agitated gently to produce maximum floc size.

Continuous Paste Mixers

The viscous nature of pastes poses a more difficult problem in continuous mixing than that presented by the more mobile liquids. Factors such as "stiffness" and "tackiness" must be considered along with Newtonian viscosity, or the apparent viscosity of thixotropic, dilatant or rheopectic materials.

Only a few machines are suitable for continuous mixing of pastes. Basically, mechanical principles that can be incorporated in such a mixer are limited in number. Available machines can be grouped according to their ability to handle "soft" or "stiff" pastes. Disk impeller mixers like colloid mills, Fig. III-10, and finger-paddle mixers, Fig. III-3, using the retention period principle, can be used on soft pastes. Mills producing more intensive action also can be used. In this category are the Dispersall mixer and the centrifugal Versator.

Stiffer pastes require heavier machines capable of greater power input to the material in order properly to knead, masticate or roll. Therefore, they are discussed in the section on continuous mixing of plastic materials.

The Versator, Fig. III-13, discussed in a previous section, can handle pastes up to approximately 20,000 centipoises apparent viscosity. This centrifugal-type bowl machine, rotating in the range from 900 to 2,000 rpm., subjects thin film on the inside of the spinning bowl to forces of successively varying intensity. Flow within the film may be turbulent in nature and dispersion of the ingredients is correspondingly thorough. Versators have been used for mixing and blending of lubricating oils and additives, lubricating oils and soaps, detergents, resin dispersions; for gas absorption and degasification, homogeni-

Fig. VI-6—Although the outside contours of Kneadermaster blades approximate the sigma form they are actually heavier in cross section for handling heavy-duty continuous kneading. (Patterson Foundry & Machine Co.)

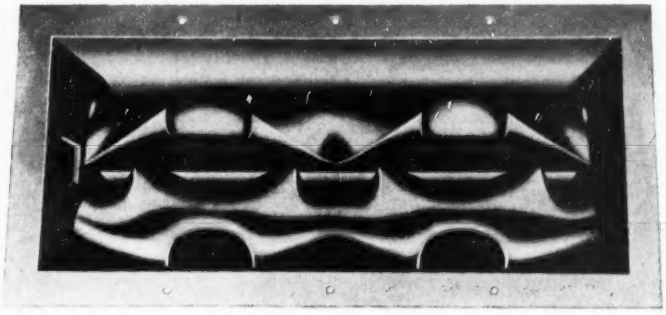
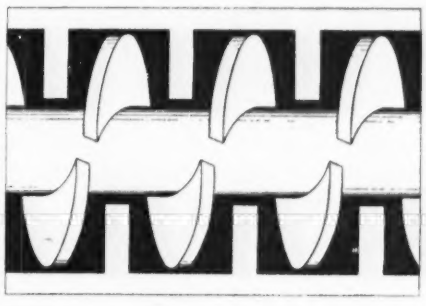


Fig. VI-7—In the Ko-Kneader material is kneaded between stationary blades and moving screw. (Baker-Perkins, Inc.)



VI—Continuous Mixing . . .

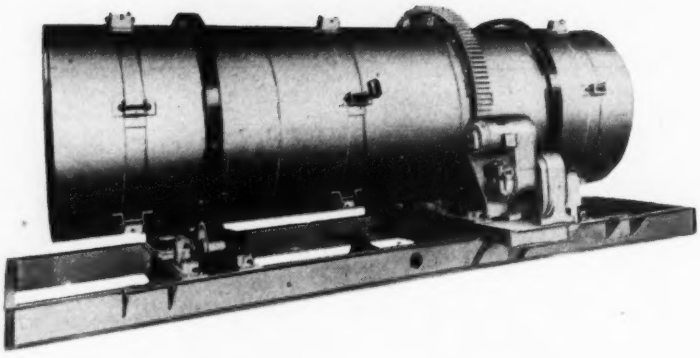


Fig. VI-9—Continuous granulator mixer finds use in converting powdered fertilizers into granular form. (Sturtevant Mill Co.)

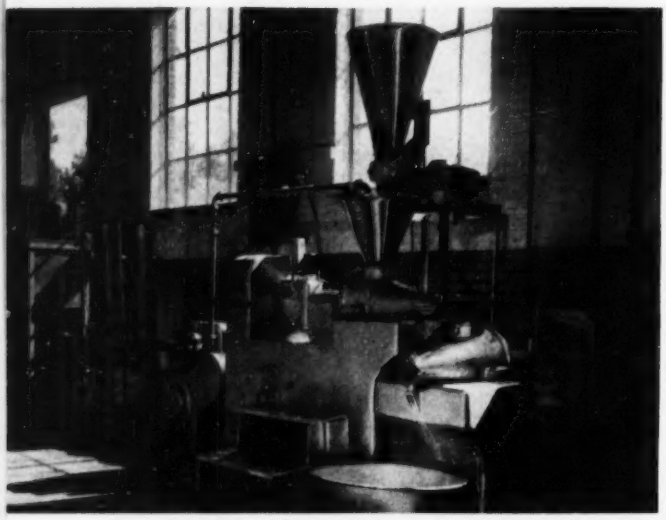


Fig. VI-11—Flowmaster continuous mixer for semi-plastic materials includes pre-mixer, homogenizer, surge tank, metering pump, dry feeder, 2 continuous mixers. (Marco Co., Inc.)

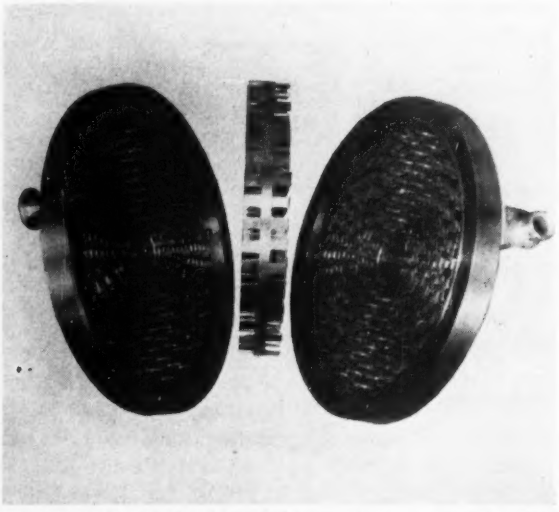


Fig. VI-10—Mixing head for Oakes continuous automatic mixer showing two stator halves and rotor disassembled to give view of intermeshing concentric teeth. (E. T. Oakes Corp.)

zation and emulsification operations on many materials.

The Dispersall Mill of U. S. Stoneware Co., Fig. VI-5, works by mechanical action similar to a colloid mill yet differs basically in not having close running clearances. Complete and continuous dispersing or emulsifying results from interaction between high speed moving surfaces, the inertial resistance of the fluid and stationary surfaces.

This machine consists of a horizontal operating tube containing a rotor fitted with six impellers. Stator plugs are attached to the tube wall and project into the spaces between impellers. The arrangement of impellers and stators creates a helical action that produces high turbulence and cavitation. The end impeller is designed to retard flow through the tube and reverse the rotational direction of the fluid. One of the discharge ports can be connected to a feed port to permit recirculation.

Continuous Plastic Mixers

Continuous mixers for plastic materials are essentially modifications of machines used on batch mixing. For example, pug mills and roll mills are enlarged to give greater capacity. This is done by lengthening the mixing chamber, for the former, and by increasing roll length and diameter, in the case of the latter.

Roll mills also are made in the multiple roll design with three to five rolls, in stack or cascade mounting, to increase time of milling.

Rate of feeding and proportioning for streamline flow must be subject to careful and sensitive control. Residence time in the mill then can be adjusted to some degree. Needless to say, processing characteristics of the material predetermine the size of mill, which will have only slight latitude beyond one product.

A continuous kneader, developed by Patterson Foundry & Machine Co., has double-overlapping, multiple-section, sigma-design blades, Fig. VI-6. Outside contours of the blades approximate those of the sigma form but the blades are filled in around the central axis to provide structural strength.

The multiple-sectioned blade repeats the original element, end for end, down the trough. Length of trough

is selected to give optimum residence time for completing the kneading process. As pictured in Fig. VI-6, feed material enters this machine at one end in regulated proportions and weights and the agitators convey it to the discharge end in the necessary time.

Patterson's kneader can mix materials ranging from light to medium consistency such as insulation, sound-deadening materials, mixtures of powders with oil or other vehicles. Where long mixing time is needed, a battery of units can be arranged, one above the other, and driven by one motor using chain and sprocket transmissions.

A somewhat different and unusual operating principle is utilized in the Baker-Perkins Ko-Kneader, invented by Heintz List. Fundamentally, the Ko-Kneader has a single worm blade revolving in a trough. However, the blade has gaps at regular intervals, Fig. VI-7. Teeth or baffles mounted in the trough wall project into the gaps in the blade. The drive that revolves the blade is designed also to move it horizontally. The two motions are coordinated so that the gaps meet and pass the stationary teeth as the worm revolves.

Material is fed into the trough, Fig. VI-8, and forced forward by the worm blade until it comes into contact with a kneading tooth. As the blade passes the tooth, it forces a portion of the material to continue moving and leaves the remainder behind for further working.

The action repeats along the entire trough as the material passes each kneading tooth. Thus each tooth, working with the gaps in the worm blade, acts as a single mixing machine. Repetition of this operation as the material moves through the trough accounts for the thorough, intense blending of the finished product. Non-uniformity of finished product because of feed variations is said to be eliminated by this type of mixing.

The Ko-Kneader covers a range from light blending to heavy, intense kneading. It is used for plastics, dyes, rubber, electrode mixtures, chocolate, margarine, soap powders and foundry sands. Machine can be furnished with either open or closed trough and jacketed for cooling or heating. Various extruded shapes can be produced through choice of extrusion heads on the outlet end.

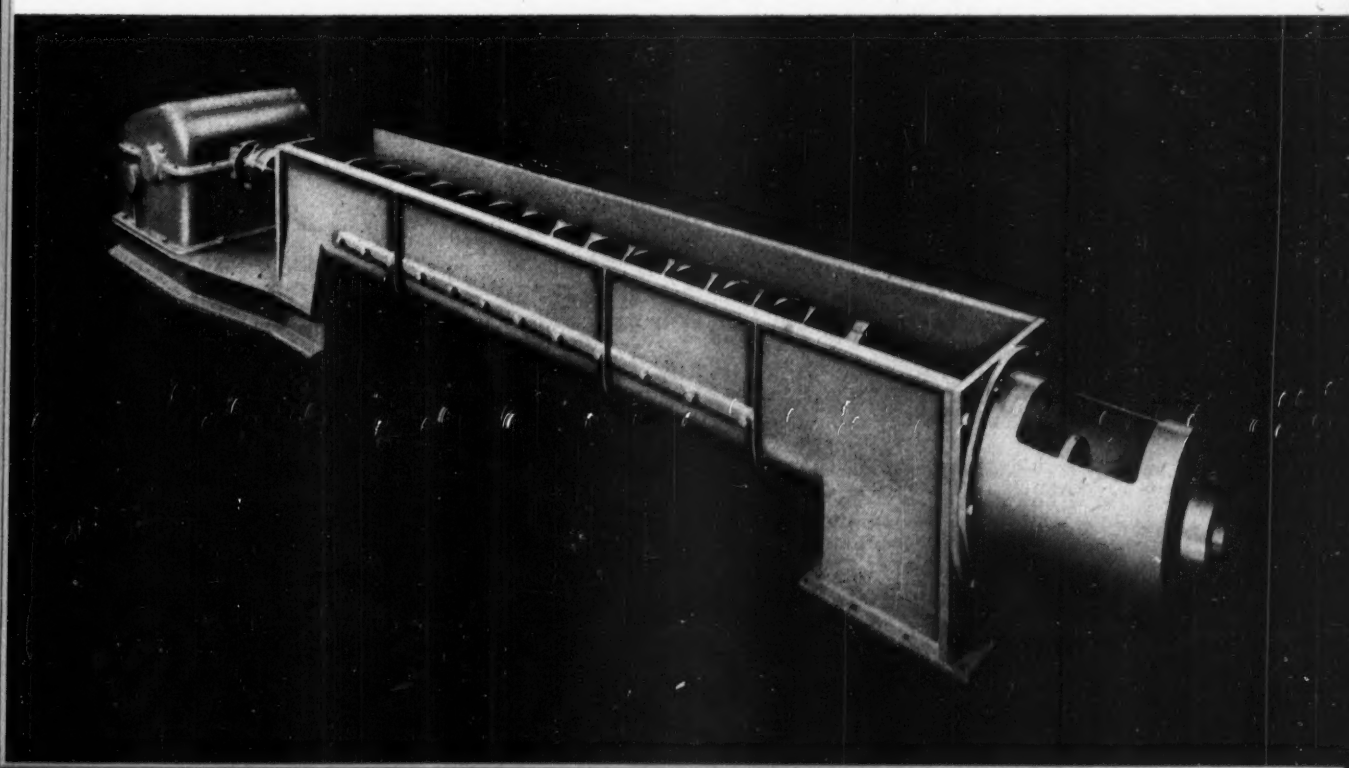
Continuous mixing of dry particulate solids is entirely feasible, Fig. VI-9, although suitable machines are limited in variety. Customarily, dry solids are stored in bins and conveyed about a plant by either screw or pneumatic conveyors. The latter devices can be adapted for mixing on a stream-line basis by the inclusion of suitable feeders or proportioners.

Mechanical action in a screw conveyor or the turbulent condition in a stream of air-conveyed material oftentimes provides adequate mixing. If the material is being fed into a storage or surge bin the stream discharging from the conveyor can be impinged on a cone or baffle placed just inside the bin. As the material slides down the cone or slope in the bin it mixes still more.

Screw conveyors can be provided with notched flights to cause some interchange of material right in the trough. A number of designs are available.

Other types of continuous mixers for solids are the impact type similar to the Entoleter, Fig. V-18, and the rotary barrel. This second type is built either with feed and discharge ports through the trunnions, or with open ends when mounted on girth rings and driven by a girth gear and pinion.

Fig. VI-8—Type M Ko-Kneader design handles continuous mixing of dry powders (soap powders) and semi-dry or semi-plastic masses (foundry molding or core sand). Materials are charged to left end of U-shaped trough and are discharged through the rectangular opening on the right end. Three basic designs cover wide range of kneading and mixing. (Baker-Perkins)



liquids, the shear stress decreases with time under these conditions. In Fig. I-7*b*, where shear stress is plotted against rate of shear as determined by a rotational viscometer, we find a "hysteresis loop" in which the loop area is a measure of the amount of thixotropy. Examples of thixotropic liquids include ketchup, mayonnaise, solutions of some organic polymers, greases, paints, and inks.

Instead of decreasing with time, the shear stress may increase with time. Then the fluid is said to be rheopectic. Rheopectic materials (Fig. I-7*a*) are those which increase in apparent viscosity upon being tapped or rhythmically shaken. Examples of rheopectic materials include gypsum suspensions in water, bentonite and V_2O_5 sols.

We should bear in mind that the properties of a fluid depend not only on its ingredients, but on such things as its concentration, method of preparation, and other factors. Properties frequently change from one non-Newtonian fluid type to another as these things change.

Measurement of Viscosity

Many industries are primarily interested in relative measurements of viscosity and therefore use viscometers peculiar to their own control testing. These are generally of the efflux type, such as the Saybolt Universal, Redwood Standard, Ford Cup, etc.

There are two general types of viscometer which are fundamental in nature and therefore can be used beyond relative viscosity measurements. The first of these is the concentric cylinder type illustrated in Fig. I-8. As dx/x approaches zero, such a unit approaches the impractical but ideal system of two flat plates used to describe viscosity. Examples of this type include the Interchemical and MacMichael, in which the cup rotates as in the figure. In the Stormer and Brookfield, a bob rotates while the cup is stationary. The last-mentioned type deviates considerably from the theoretical case of parallel plates in that dx/x is large and dx is not constant. Nevertheless, it is widely used due to its mechanical perfection.

The second type of fundamental viscometer includes the capillary tube and pipeline types. Since Poiseuille's law defines viscosity in terms of pressure drop, streamline flow through a small tube or pipe may be used to calculate μ from pressure drop, flow velocity and tube dimensions. It should be noted that the flow must be viscous since in turbulent flow both density and eddying of the fluid are also involved in addition to viscosity. Examples of viscometers of this type include the Ubbelohde, Ostwald-Fenske, and SOD viscometers.

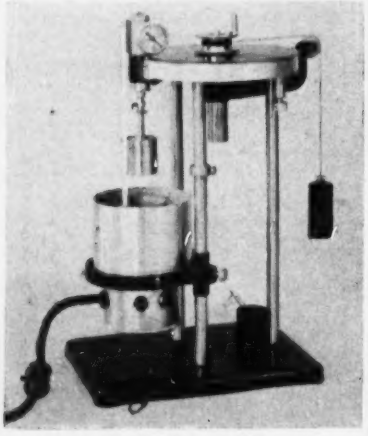
In addition to the fundamental types listed, there is a variety of empirical viscometers which make use of a falling ball, disk, or cylinder (as in the Gardiner Mobilometer); use the efflux of liquid through an orifice (as in the Saybolt and Engler viscometers); or employ a baffled concentric cylinder, as in the "modified Stormer." Such viscometers are used primarily for special restricted applications, for example, the Saybolt in petroleum oils, the Gardiner in paints, and both only for routine control testing. Such empirical viscometers must be first calibrated with a liquid of nearly the same viscosity and density as that for which they will be used.

In measuring apparent viscosity of non-Newtonian liquids, one must be able to take readings at various shear rates if the results are to be useful. In the case of thixotropic and rheopectic liquids, the duration of shear also must be variable. Such tests are generally possible with concentric-cylinder type viscometers, but usually cannot be accomplished with the capillary and empirical viscometers. The latter are able only to show the kinematic viscosity in an almost quiescent state. They cannot give the apparent viscosity of the liquid under conditions of agitation.

Other Properties

Density (or "specific gravity") is important in mixing as it relates to viscosity in the form of kinematic viscosity, μ/ρ. In addition, it is important from the viewpoint of power consumed in mixing and from the standpoint of the settling velocity and keeping solids in suspension.

Surface tension is a property of liquids which is of importance mainly when emulsions are to be prepared by agitation. Ease of wetting, however, which is a property connected with surface tension, is of importance in the dispersion of solids.



Among many types of viscometers, only a few such as the Stormer (Arthur H. Thomas Co.) at left, and the Brookfield (Brookfield Engineering Labs) at right, can be used for non-Newtonian liquid measurements.

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→ **Automation—the use of computers which completely control and monitor a process from start to finish.**

● **It's on the way now. What effect will its arrival have on the functions and structure of management?**

● **Here is one answer. And it's what you should know in order to prepare yourself for its coming.**

Managing the Automatic Plant

CHARLES E. KNIGHT

THE TRULY automatic plant may not be built for some time yet—although steps are now being taken in that direction. In any event, it is not too early to take a look at the effect that automatic production will have on the shape and nature of plant and corporate management.

What Is Automation?

A good many of today's processes are highly instrumented, products are turned out in an almost endless stream "untouched by human hands." Is this automation? What IS automation, anyway?

For one thing, automation involves far more than mere instrumentation. The automatic plant will probably consist of one or more continuous product lines—each completely controlled, analyzed and monitored by computers—from raw material ingestion to finished product shipment.

Automation will eliminate human decision and control at all but the highest levels. In fact, even surveillance will be unnecessary.

With automation, the human element in production will be confined to the programming and maintenance level. Highly trained personnel will be required to feed the proper signals—in the form of punched tape or cards—to the controlling mechanism, and also to repair and adjust the process and electrical equipment.

The unit will run continuously, shift from the production of one product to a related one automatically and without equipment changes, on signal from the control computer. These same controlling and monitoring computors will also be made to turn out a continuous stream of information on quality, cost and unit performance.

How Far Off Is It?

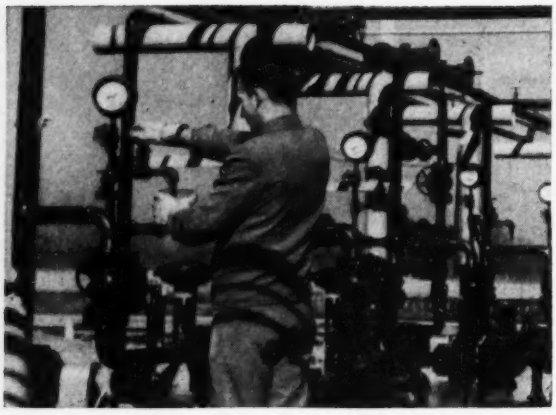
The completely automatic plant is not as far away as you may think. Many of the techniques of automation have already been developed, others need only to be refined. All must be brought together and integrated.

One technique, expected to be the cornerstone of tomorrow's management structure, is operations research. This involves the application of the "scientific method" to the broad problems of industry—procurement, production and distribution. OR groups have already been formed in many present-day companies.

Electronic instrumentation, mecha-

CHARLES E. KNIGHT *is plant engineer at the Springfield, Mass., plant of Monsanto's Plastic Div. His article is based upon a paper which he presented to the Automation Symposium of the ASME's Management Div. Dec. 1, 1953, New York, N. Y. It is expected that the complete symposium will be available from the society.*

Guesswork not only permits variation in product quality, but it can also be a bottleneck.



Indicators show process conditions at any given time and help the operator control them.

nized accounting, teletype communication—these are other techniques of today which will be found in the plant of the future.

Today's modern refinery, unattended power station or large chemical plant is the prototype of tomorrow's automatic plant. For many segments of the chemical industry, complete automation is not too far in the future.

How Will Tomorrow's Management Operate?

- **Longer and more detailed programs.**
- **Closer integration of departments.**
- **Stress on people and communication.**

Management in an automatic industry must be as streamlined and progressive as the plants themselves. Concentration of new skills in fewer workers per unit output will require intelligent, versatile executives who can rub elbows with scientists and engineers and talk their language.

The functions of these future executives are more important than the exact management structure needed to carry out their operations, since the structure will vary from industry to industry, company to company.

Under automation, management will face new problems. It will be necessary to increase emphasis on some present activities, deemphasize others. Some which are separate now, may be combined, others will emerge distinct. In all phases greater skill, greater adeptness, will not merely be desired, it will be required.

Longer Look Needed

With the greater investment in plant and equipment required by automation, policy makers will be forced to look and plan much further ahead.

It will be necessary to take a longer view at all levels of company organization. Ten, fifteen and twenty-year programs will become rule. With a greater amount of capital tied up in the plant investment, continuous, uninterrupted production must be assured. Markets will have to be so developed as to minimize seasonal changes and short custom runs.

Corollary to this, companies will be required to venture larger amounts of capital on the introduction of new products in an effort to insure their "catching on."

Planning More Complex

To achieve this longer look ahead, more detailed preparations will have to be made. Policy makers will want more and better-organized data, vulnerable to quick yet thorough analysis and interpretation. And then, before a step is taken on the course set by the policy-makers, a complete and detailed analysis will be made of all possible factors—markets, raw materials, plant design and capacity, location and personnel and other factors—which may bear on the result of the company's action.

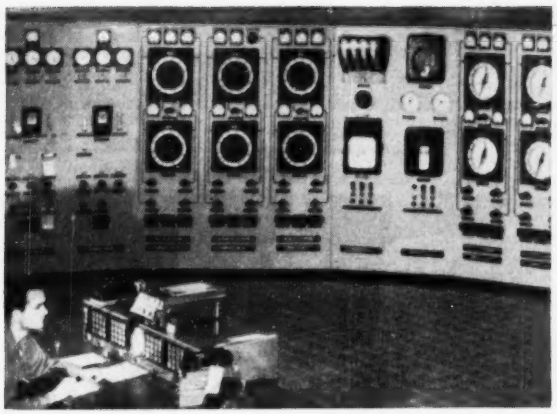
Use of a "forecasting" computer, acting on this information and other known variables, will help the company predict the effect of its action upon itself and its goals. This may seem Utopian, but, to explore adequately the long-term effects of any changes in these variables, some means faster than the human brain must be employed.

Actually, the computer approach is not nearly as Utopian as it sounds. It has already been used with success by the Armed Forces to facilitate long-range logistical planning and to carry out operations research.

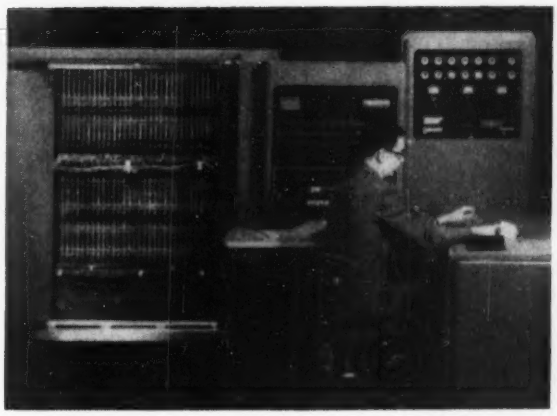
Up-to-Date Accounting

Human judgment and decision will be all-important at the top level. Armed with the advice of their research staffs and of their financial specialists, top management will be charged with capitalizing new plants and expansions, prescribing the rate of return on investments and distributing funds to production executives.

Most of the accounting will be done by automatic devices. These will translate information inputs into continuous up-to-date accounting records. Well-trained personnel will be required to feed the proper information and interpret the output. Accounting talents will be in great demand for the computer operation and financing phases of the business.



Recorders may also control. They show present conditions as well as the continuous history.



Computers of the future will completely control, monitor an analyze all phases of the process.

New Look to Production

The automatic plant itself, the production line unit, will be designed with the end product in mind and each unit will be integrated with others. Production of a family of similar commodities will often be envisioned.

Subject to computer observation and control, the line will be capable of switching from one product to another without changes in the equipment. Modifications in the functioning of the line components will be effected by altering the orders to the control computer.

With automatic materials handling and no in-process inventory, buildings should become smaller and more compact—more functional. Smaller production working forces requiring less space for locker-rooms, lunch rooms, etc., also mean reduction in building needs.

Work Force Altered

The production work force as it is known today will be drastically altered. Strict production personnel will be limited to computer technicians programming the line—plus maintenance men.

Maintenance of the automatic equipment will be mostly preventive, and require more highly-trained and versatile engineers and craftsmen. Of course, ease of maintenance will be designed and built into the equipment, for with the tremendous capital investment, continuous production will be a necessity.

Such aids to maintenance as standardization of parts and instrumented trouble-shooting will help maintenance personnel prevent breakdowns.

More and Better Controls

To control and monitor the production line it will be necessary to use highly developed computers and business machines. In addition to their monitoring function, they will be able to turn out continuous information on quality, cost and general unit performance.

More nearly uniform product and faster data gathering and reporting will result.

More Closely Integrated

With the automatic plant gobbling up raw materials and spewing forth finished products continuously, all departments, from procurement to sales will have to be more closely integrated and better informed as to each other's operations.

Raw materials will require closer scrutiny and a longer planning range. Uninterrupted supply, uniform quality and proper records will be of paramount importance to facilitate carrier-to-line handling and prevent costly delays.

Sales, too, will have a bigger job with the advent of automation.

Markets for larger quantities of related products must be developed—with seasonal cycles ironed out. Small or custom orders will have to be coordinated to keep interruptions of the production organism to a minimum.

Another very important activity of sales will be the supplying of market information to the rest of the company. The flow of market information must be more detailed, faster and in a form suitable for input to the forecast computer.

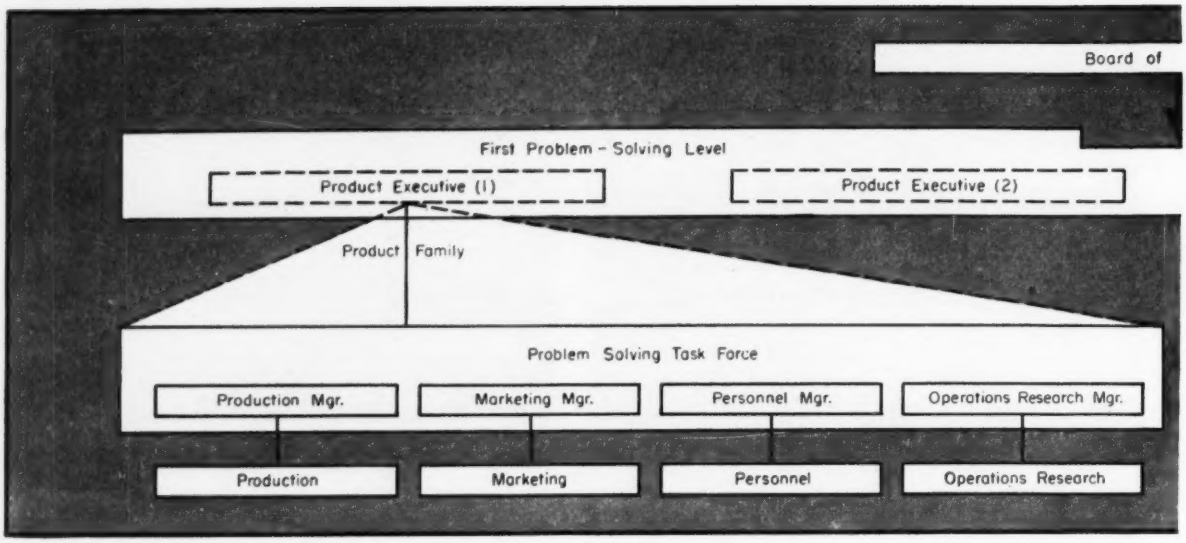
Embraced in the sales organization will be the product distribution group. This group will be charged with providing the necessary transportation to fill the customer's orders. It may also include a staff of specialists to maintain liaison with legislative groups in the state and nation.

Stress on People and Communications

Personnel for the automatic plant will be fewer overall but there will be more highly-skilled workers per unit output. In this environment, the selection and development of suitable people will assume tremendous importance. A more technical background will be required at all levels. Training of all personnel will be longer and more costly, the penalty for failure higher.

With fewer but better skilled workers, teamwork will be all-important. Much of the work, much of the information exchange, will be carried out horizontally, since speed will be most important. Coordination must be closer, and it will be imperative that more people know each other's business.

Communications will be important as never before. Two-way radio, closed-



ORGANIZATION of management for automation may well be along these lines. Product executives will become important cogs.

circuit television, and other systems will move important information faster.

Further, better skilled men must be better informed. They will require, and demand, more information about their jobs and how those jobs fit into the over-all company plans.

What Shape Will Future Management Take?

- **No single shape can be assigned.**
- **Endless variations will appear.**
- **Here is one possible structure.**

Anyone with pencil, paper and imagination could sit down and conjecture about the structure of tomorrow's management. There would of course, be no right and wrong, because tomorrow's management—like today's—will vary all over the map depending upon the industry, size and personnel of the individual company.

While it would be folly to say, "This is IT—there'll be no other", here is a possible solution (conjecture, if you will), based upon a critical look at the requirements of the automatic plant and the trends in both management and technology.

A Little Strange-Looking

The organization chart for the plant of the future will look a little strange to today's eyes—for much of the organization will have to be built, like the plant, from the ground up.

Centralization and rapid communication will be hallmarked. With the extensive use of new mathematical techniques, electronic calculators and the like, data gathering and analyzing will be done with hitherto unattainable speed. This will put the central office into immediate contact with sales, production, financial or inventory problems.

At the top of the organization chart there'll be a group to function much the same as today's board of directors. These men would be the long-range policy makers. Raising funds, determining the rate of investment return, liaison with stockholders and the selection of production executives will fall in their laps.

New Cogs in the New Wheel

Product executives, each of whom heads a complete product family unit, will be the most important cogs in automatic industry's wheel. They, together with the head of the research and development department, will make up an executive board—the top-level problem solving group. To them will fall the responsibility for attaining the company's financial objectives. Armed with data obtained by their organizations, they would pool information, analyze it together and determine the specific course to be taken.

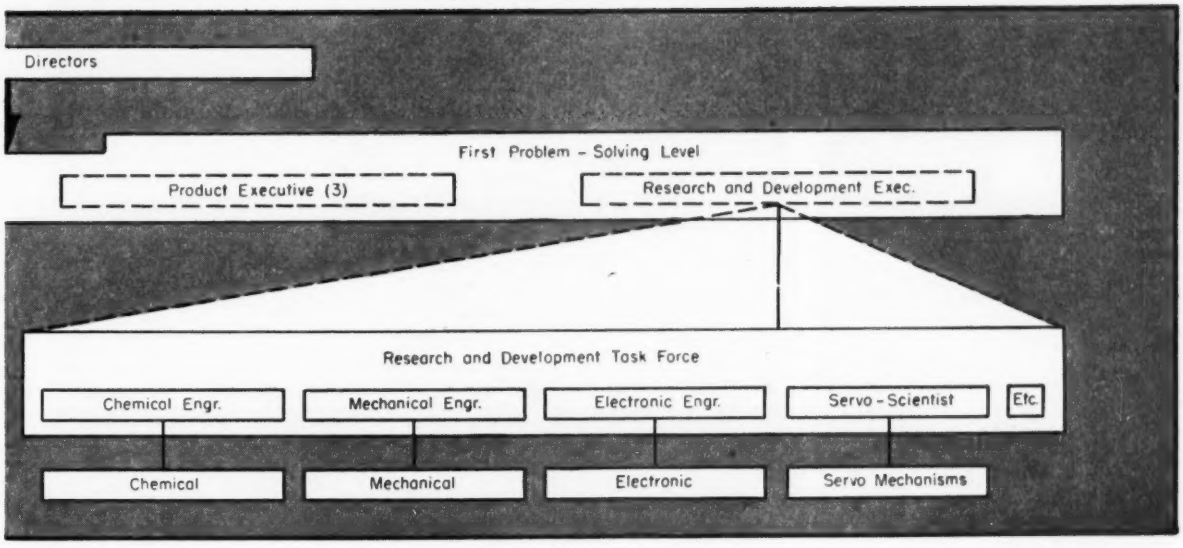
It is here that the forecasting computer will be used—to digest the plans of production and research executives and predict the long-range effects on the company as a whole. To do this, mathematical models of the various plants and their interrelationship with the economy as a whole must be constructed in the form of equations which can be built into the computer.

With these computers, the effects of changes in conditions both within the company and outside of it can be simulated by altering one or more of the variables. These will put the complete picture of any production or marketing situation before the product executives.

No "Ivory Tower" for Research

The research and product development group will be a separate activity at the product executive level. This group will receive market intelligence from the various operations research units and direct its efforts toward evolving new products and improving exist ing ones.

Actually, there will be little change from today in the function of this



Each will head a product family and, with the research head, all product executives will form a top-level problem solving group.

department. It will be more important than ever, however, that research and development be closely integrated with the total industrial effort.

Plant Divided Into Four Groups

The staff of the product executive will be the heads of the plant divisions — operations research, production, marketing and personnel. These form a problem-solving task-force—plant level. Using rapid communications and easy conference-holding facilities, this group will handle most inter-departmental problems laterally, with a minimum of up and down the line referrals. They will also be charged with briefing the product executive for his contributions to the first-level problem-solving group.

Led by Operations Research

The transition from today's modern factory to the truly automatic one will probably be preceded by the formation of an operations research group.

Primary concern of this group is the gathering of information and its evaluation. Probability theory and statistical analysis will be used to construct mathematical models for the industry, plant and process. These will provide the basis for determining the optimum performance of the integrated, computer-controlled plant.

Since operations research will require access to nearly all plant records in its quest for information, it seems logical to have it provide the accounting and other business-control services requiring statistical analysis and reporting. Computers and business machines will help the OR group prepare the data in the best form for analysis. Rapid communication systems will speed these data to the proper departments.

Production Handles All Engineering

In the automatic factory it will be virtually impossible to separate the functions of production, maintenance and material handling. Except for programming the line, all of these functions will be included in maintenance. Production personnel for the most part will be engineers, technicians and skilled craftsmen.

In the company of tomorrow, plant design and construction may be too much a part of production to be separated from it. Ease of maintenance must be engineered into new construction, therefore, the philosophy and aims of both design and production will be too nearly alike to allow separation on departmental lines.

Marketing Activities to Expand

The marketing department of the future may very well embrace many activities not now in its baliwick. It will be charged with nearly all of the company's outside activities. Sales and advertising will fall to this group as at present, but it may also handle purchasing, traffic, shipping, inventory control, receiving, disbursing and billing—the last four operations taken care of by business machines.

Biggest job of the marketing manager will be to inspire teamwork, for despite the varied activities of the department it will be necessary to have a constant and rapid flow of information both within the group, and to other groups within the company.

Fewer, But Better-Trained Men

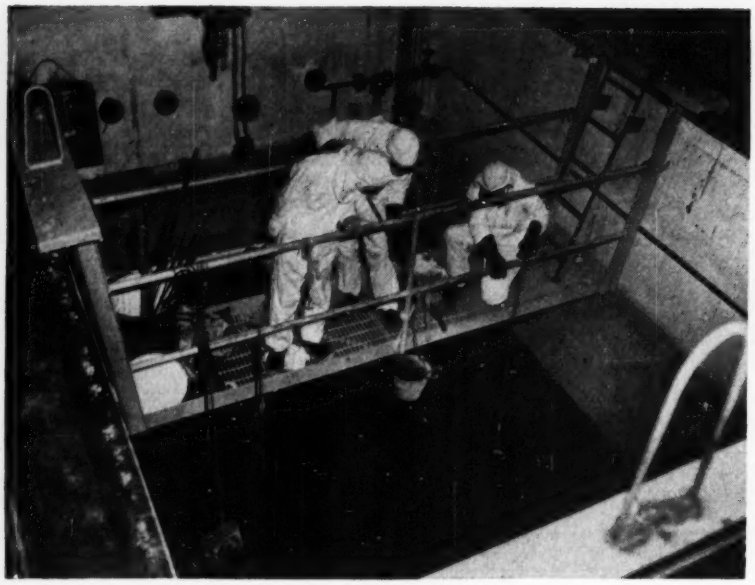
The personnel department will take on increased significance under automation. In addition to its usual functions of personnel procurement, training, health and services, it will probably include plant protection, safety and salary disbursement.

It will place renewed emphasis on personnel procurement and training.

For with the tremendous capital investment necessary for the plant, management will want only properly fitted people on the job.

Further, the better-trained worker will require more information—about his job, his group, his plant and the company as a whole. It will be up to the personnel department to keep him informed.

KEEPING RADIATION OUT



REPAIRING pipe jumper gaskets with long-handled tools.

Where Maintenance

Process equipment for nuclear chemicals means mechanical simplicity, standardization, leakage control and no valves. Plan for maintenance-by-replacement.

In the good old days maintenance work followed a fairly definite pattern. Work could be planned in detail and scheduled accurately. Material and spare parts were those commonly used in most plants, and easy to obtain. We could control costs and establish maintenance budgets. But a new approach must be used to keep the production of nuclear chemicals going.

Many parts and materials are of special kinds. Requirements have to be forecast far into the future and procurement established well in advance of needs. Sudden changes are the rule.

It wouldn't be so bad if you could get in there and get your hands on the stuff. But the equipment used for handling nuclear chemicals becomes radioactive also. This may prohibit any manual repair (so-called "contact" maintenance). Just to give one example, we recently removed a defective processing tank from service. At a distance of 125 ft., the maximum permissible personnel exposure time was 26 sec. This time limit dropped to 4 sec. at 65 ft.—a situation hardly conducive to the normal hand wrench kind of maintenance.

You can try to decontaminate equipment like this to workable radiation levels. Sometimes it's cheaper to throw it away. Even when decontamination and repair are worthwhile, the time required to do this is much greater than production can stay down. To keep some things moving we have to use maintenance-by-replacement. And this means replacement by remote mechanical means from shielded hazard-free locations to protect the employee.

Even when the men can get in and do some work, they wear two suits of coveralls, leggings, rubbers, a full-face mask, and two pairs of rubber gloves.

Recently a radioactive chemical solution was being pumped from one underground tank to another. Suddenly a pump failed. We couldn't just

DISMANTLING a pump and impeller to determine the cause of failure.

Is Really Tough

lift out, examine and repair the pump as would be done in an ordinary plant. A check with the plant weather station gave us a forecast on the probable wind velocity for the next 12 hours. Replacement of the pump would take that long. And on an outdoor job like this a strong wind would spread contamination. Covering the ground with heavy paper would help somewhat to control this.

A maintenance crew with five crafts was assembled and they put on heavy protective clothing. The men were numbered for identification and we set up radiation time limits and controls so that a time keeper could record exposure periods. A large motor crane was brought to the location and spotted. After attached service lines were disconnected the pump, wrapped in a plastic bag, was taken away for burial. We installed a new pump and production continued.

Even routine repetitive maintenance jobs assume unusual proportions at this plant. Putting new gaskets on pipe jumpers is typical. In some of the process buildings where plutonium is separated from its parent uranium, there are a series of cells. In any given cell one step of the over-all chemical reaction takes place. The solution moves from one cell to the next through jumpers all the way down the line. Gaskets make tight connections on the jumpers. Sometimes they leak and have to be replaced. In outside industry such a task would be very simple. But not at an atomic plant. Here is how it's done.

First an electric wrench, remotely controlled and operated, and observed through a periscope, loosens the jumper. A crane removes it from its original location to a deep concrete cell and the jumper is submerged under several feet of water. This water provides radiation protection to workmen. Then several maintenance men, wearing full protective clothing, enter the area and go to a catwalk at one side of the cell. The gaskets are removed by means of long-handled tools. It's as hard to regasket with extension tools dipped into water this way, as it would be to use a four-foot fork to eat spaghetti.

KEEPING RADIATION IN

This article was prepared from two papers presented at the 1953 Conference on Nuclear Engineering: Univ. of Calif. at Berkeley. Authored by O. C. Schroeder, Supt.-Reactor, and K. K. Campbell, Supt.-Power and Maintenance, General Electric Co., Hanford Atomic Products Operation, Richland, Wash.

DAMAGED TRANSFER PUMP, too "hot" to repair, is replaced.

Another constantly repeating job is diversion box work. This box is a rectangular concrete pit located outdoors with pipe connections along opposite sides, and used to change connections from one pipeline to another, through jumpers. In the normal industrial plant, such a change would be made by turning some valves. Here, where radiation levels are high, valves can't be used. If they fail, they can't be repaired. Instead we use a motor crane with a long boom. The crane operator lowers an electrically operated wrench into the box from 20 ft. away, viewing his work via mirrors.

A single change of one jumper requires a crew of not less than seven men, all of whom are dressed in protective clothing and working on time limits.

REPAIRING IN PLACE

Sometimes you just have to repair in place. On another repair job it was necessary to change a bearing on a fan shaft. Essentially all that was needed on this job was to install a new ball bearing in place of the damaged one. A check on the radiation established a maximum of six minutes exposure time for any one man in a 24 hr. period. The work was urgent because there was only one spare fan. So 30 mechanics were scheduled for the job.

Of course you don't expect to have such a large group of men readily available for work of this kind. To assemble such a large number, additional men were brought in from distant parts of the plant.

The job was started with two mechanics. When the time was up on the first pair of men, two more were sent in after being informed of the progress made. Then this pair worked for their allowable time and came out. And so the work progressed. At the end of three eight-hour shifts the fan bearing was repaired, tested and the fan was back in service. Where else would 30 mechanics be needed to change a bearing?

Here then might be an order of magnitude summary of how a typical nuclear job stacks up against a comparable job in conventional plants. The atomic worker needs costly equipment like periscopes, radiation meters, extension tools, special clothing and equipment.

He will spend three to five times as long in actual working hours to complete a given job. In addition, because the employee sometimes receives a full day's permissible radiation exposure before his shift is over, the labor cost for a single job is always higher at the atomic installation.

The atomic maintenance problem is made still more complex by the fact that nearly all the production operations are performed remotely using extensive instrumentation and automatic electrical and mechanical devices. Considerable use of automation means there is a correspondingly larger chance of equipment failure somewhere along the line.

Six Rules

1 **Incorporate maximum accessibility and ease of replacement into the unit.**

2 **Avoid false economy. Don't save pennies in original equipment costs and spend dollars later maintaining it.**

3 **Split units into replaceable components. Repetitive design patterns are an aid to maintenance by remote means.**

HOW DESIGN HELPS MAINTENANCE

Maintenance problems in atomic installations are tough. Workmanship must be superlative. As an example, the quality of welding is important. We found it necessary to give special training classes to instruct men in welding platinum, gold, tantalum, and plastics, as well as stainless steels.

But no matter how good the workmanship, it is no substitute for wise design. We found through experience and headaches that many standard manufactured items of machinery don't meet the demands of plutonium production.

The pump which never needs to be repacked, the bearing which never needs to be lubricated, and the trouble-free valve just don't exist. We've tried to counterbalance these deficiencies by intensive design study of the experience that maintenance men have gained in the first atomic decade.

There was little supporting experience to go on in the early 1940's, only the recognition of the unique problems and hazards created by one of the by-products of the plutonium creation process: radioactivity. We needed a

For Design

4 **Standardize equipment wherever possible.**

5 **Select the proper materials. Test with acids, caustics, extreme temperature and particularly radiation. Singly or in combination they are important factors to be considered.**

6 **Most important of all—make it simple. The simple unit has less chance for failure.**

completely new concept of design.

Of the several design bases considered, (mechanical simplicity, standardization, leakage control and the rest), we won't attempt to establish a priority list since the relative importance varies with the specific problem.

MECHANICAL SIMPLICITY

Mechanical simplicity is a must. Any complexity not needed for process duty is removed. Moving parts mean wear, adjustment and lubrication.

Where mechanical devices are essential, analyze for weak points. Strengthen them. Design around them. If you can, get rid of them. The failure of a single 15 cent gasket in the inaccessible zone might be responsible for the discard of a $20,000 piece of precision machinery.

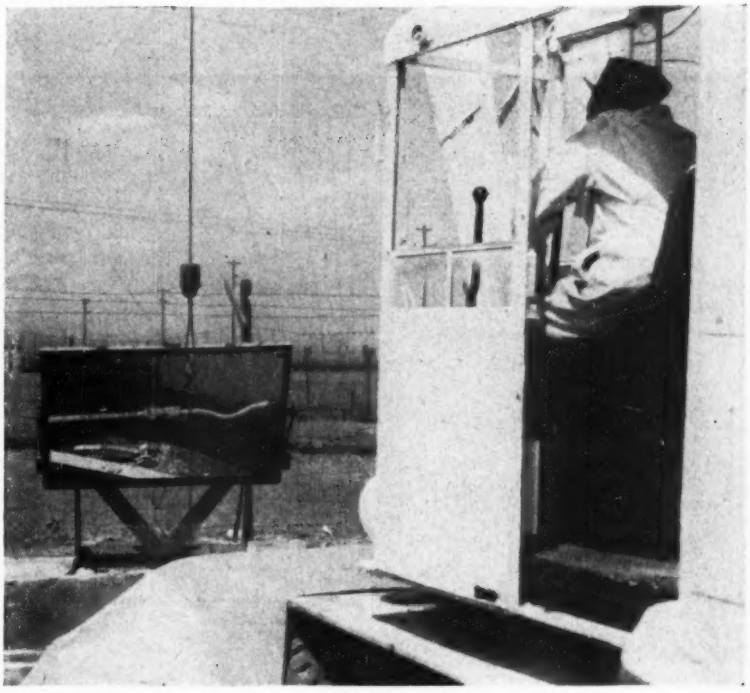
Any time you spend in pre-design anticipating trouble is well-spent. Gross over-design in points of stress or expected failure is often a cheap price to pay for longer equipment life.

As an application of the principle of mechanical simplicity, the original production facility for the chemical separation of plutonium has no process valves or pumps in the radioactive zone.

Movement of liquid is handled entirely by steam jet. Multiple distribution of process liquids, usually handled by valving from a manifold, is accomplished by installing individual transfer lines. Each line has its own steam jet prime mover. This simple concept has an excellent performance record.

STANDARDIZATION

Standardization of equipment is a must. It reduces design costs, capital investment and spare parts inventories.



TO GET RID OF VALVES, pipe jumpers are switched remotely.

The degree of standardization shows up quickly in the spare parts inventory. To insure continuity of production we purchase at least one complete unit of each type of equipment in the inaccessible zone (piping excepted).

Assume that a process uses 15 process pumps in the inaccessible zone each operating under somewhat different suction and discharge conditions. These special precision-built pumps may cost $5,000 apiece.

With no attempt at standardization, the minimum spare pump inventory would be $15 \times 5000 = \$75{,}000$. You can visualize the savings if we could reduce the number of standard pump sizes held in reserve to three, or even one.

And there's one other advantage of repetitive equipment patterns. The effect of a ready reserve of operating equipment is created within the operating plant itself.

LEAKAGE CONTROL

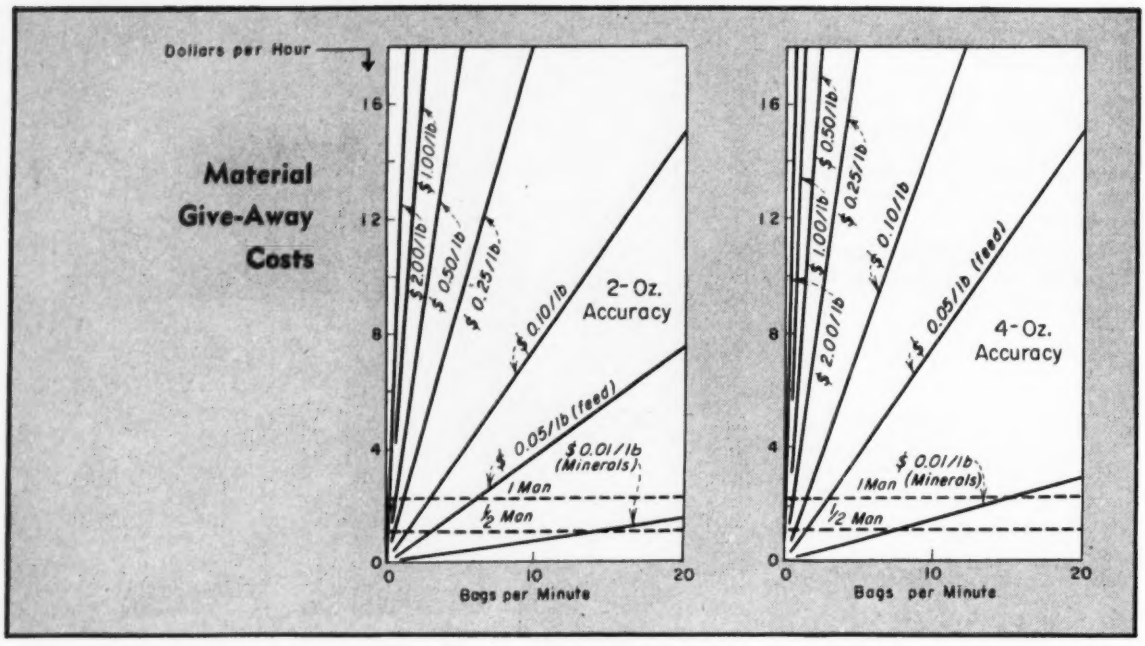
The leakage of process liquids in the radioactive zone created no unusual problem since a field of high flux already exists there. But there are good reasons why such liquids should be positively controlled and confined at all times. The solutions are valuable and air currents can spread contamination throughout the plant. As equipment is relocated, removed for repair or replaced, dripping leaks are intolerable.

One interpretation of the minimum leak point attitude deserves particular attention. Don't use bottom outlets on processing vessels. When there's a liquid head in the vessel, or in some connected equipment, there's a possibility of uncontrolled leakage through defective outlet coupling.

To get away from bottom outlets we move liquids by overflow, by suction through a dip leg, or by delivery via submerged pumps or jets. Pneumatic displacement of active liquids (the acid egg principle) is not favored because the energy stored in the compressed gas is not completely controllable under all conditions.

To control contamination, all process lines must be sloped to drain completely to one or both terminal vessels. No traps or pockets are permitted. Always try to have positive control of flow from the zone of least contamination to the zone of greater contamination.

Valves or check valves are not considered adequate protection against back flow.



DOWN WITH BAGGING COSTS

ARTHUR J. BURKE

It's easy to lose money— *4 Ways you may be wasting bagging dollars*

1 Weight Give-Away

Weights-and-measures regulations and often customer goodwill make it necessary for a processor to set the mean weight on his bagging scale higher than the nominal weight. Thus, no bag falls short in weight. The mean weight or scale setting consequently is above the nominal weight by the amount of the maximum weight variation, resulting in a give-away of material practically in every bag.

For old, sluggish and poorly-maintained scales the weight variation may be considerable. Losses may be especially high when bagging at high speed or bagging an expensive commodity.

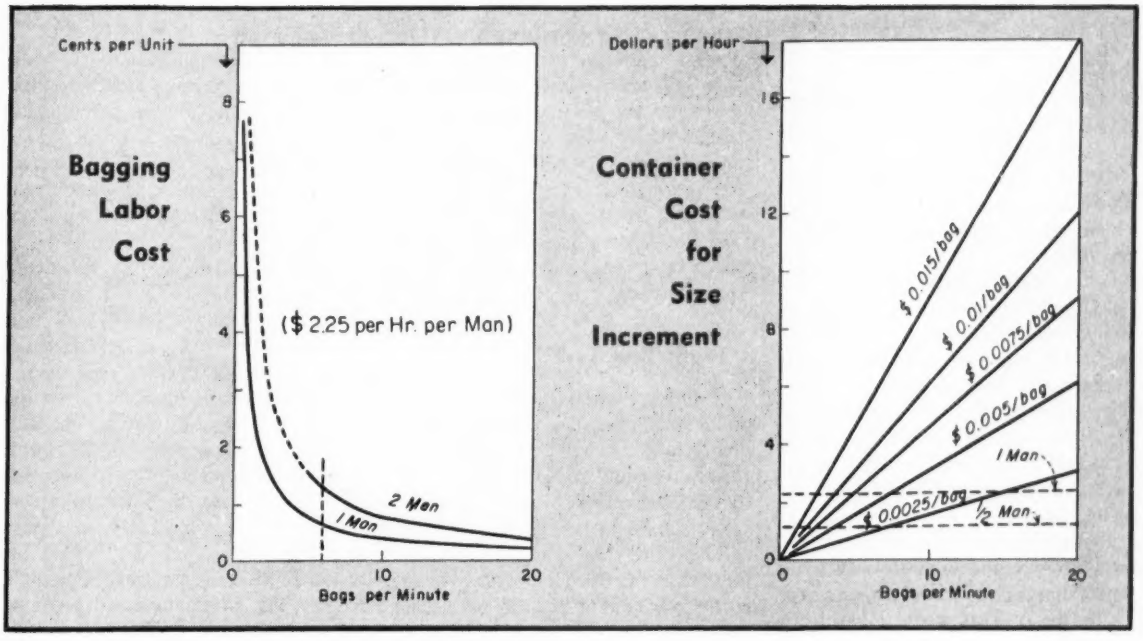
For instance, when bagging a commodity worth 10¢ per lb. at a rate of 12 bags per min., even a 4-oz. give-away costs $18 per hr. In bagging a chemical worth 25¢ per lb. at a rate of 4 bags per min. a 4-oz. give-away would cost $15 per hr. (See charts.)

Arthur Burke is chief engineer of the Richardson Scale. Co. He has been studying problems of weighing and bagging bulk materials for the past 18 years.

2 Excess Labor Costs

It costs $3,500 to $4,500 per year in process plants for one bagging operator. The amount includes miscellaneous benefits. Using the higher figure, labor costs are charted for one and two-man bagging systems.

Some installations require additional labor. Standby labor, for instance, may run as high as 20 to 33⅓ percent of ordinary labor cost. Maintenance may require one extra hour of labor in an 8-hr. shift. If it is necessary to consider both maintenance and standby labor, they may be covered by a 50 percent increase.



These costs may often be reduced by purchasing equipment requiring less manpower.

3 Wrong Bag

Bag cost, like weighing-inaccuracy cost, varies with the speed of operation.* At high speeds, it takes on real significance. For instance, a medium-priced cloth bag 1 in. too large at bagging rates of 4 bags per min. costs about $2 per hr.; at 20 bags per min., $9 per hr. (*See chart.*)

Bag cost, too, depends on type and size. Types might be considered as open-mouth (paper, cotton & burlap), and valve. Remember that changes in bag sizes are not uniform. Size changes, for example, in paper may be in width as well as length. In cotton and burlap, size changes generally are in circumference or length. These lengths are standardized pretty much at 30, 31, 36, 37 and 40 in.

How much more expensive is the valve bag? A valve bag performing a given bagging operation may be smaller than the open-mouth bag required to perform the same operation, because there is no extra material required for the handling and closing of the valve bag. Yet, the valve bag will usually cost more for the given operation. For example, two typical fertilizer bag sizes are a $14\frac{1}{2}\times3\frac{1}{4}\times30\frac{1}{2}$ in. valve bag and a $15\times3\frac{1}{4}\times32$ in. open-mouth paper bag. The valve bag costs $\frac{1}{2}$¢ more than the open-mouth bag and the tape, thread and cotton filler cord used to close it.

When the same sizes are compared, the difference in cost is naturally greater. For example, a $15\times5\times30$ in. valve bag (4 ply 3-60 and 150) costs approximately 1¢ more than a $15\times5\times30$ in. open-mouth bag, of similar construction and material used to close it.

When the difference in cost for the same bag size is 1¢, there is over $50 savings per 8-hr. shift when operating at rates of 20 bags per min. When bagging at 6 per min., there is a savings of about $8 per day.

Note, however, the difference in cost is less when smaller bags are compared. Reason: in the range of smaller sizes, open-mouth bags come with extra material on top to facilitate closing.

How expensive are small changes in bag size? Slight difference in paper bag size, such as 1 in. change in either length or width, involves in many cases such a small difference in cost that it may not be significant. But a 1 in. change for cloth bags costs from $\frac{1}{2}$¢ per bag and up.

4 Improper Amortization

A nationally known process company is amortizing its equipment in three years.

How much could this company afford to spend on equipment that would eliminate one man from a bagging operation? Figuring the cost again of one operator as $4,500 per year, the cost under a three-year amortization amounts to $13,500. At a 52 percent federal tax on the income to the company which would be realized by the purchase of the new equipment, a $6,500 investment is in order.

A company, however, may find it desirable to streamline an operation in preparation for a highly competitive period in spite of current profit incentive. By and large, most processors change their feeling toward amortization with the business outlook, just as most people change their attitude toward investments with the business outlook. (*Turn page*)

* Bagging operation referred to throughout is applicable to bag sizes of 50-lb. and up.

Down With Bagging Costs—*5 Possible Ways of Cost Cutting*

1 Right Bag Size

In a speed-up, one extra inch of cloth in the bag may be the difference between the success or the complete failure of a bagging operation. Take an extreme case for an example: a speed-up for two men from 6 cloth bags per min. to 20 bags per min., which would be an absolute top for two men.

As a result of the speed-up, we would reduce labor from \$0.0125 to \$0.0036 per unit, saving \$0.009 per unit. (See chart on p. 243.) But, in a speed-up it is often necessary to use larger bags to ease bag handling at the higher speeds. In this case, using a conventional cloth bag, there would be no savings if the bag length had to be increased 1 in.

If the size-increase were not necessary, however, the \$0.009 would represent about \$21,000 in a working year (2,000 hr.). This would allow for a \$31,000 investment for new equipment, using the 52 percent tax and the three-year amortization.

2 Boost Production

In bagging chemicals, poultry feed or other relatively high-cost commodities, a speed-up is not worthwhile if accuracy is compromised. There is little risk in a speed-up, however, when low-cost commodities such as minerals are being bagged.

For example, as a result of the extreme speed-up mentioned above, there was a \$0.009 savings per bag. If this speed-up resulted in a 3-oz. greater inaccuracy bagging poultry feed (5¢. per lb.), or a 1-oz. greater inaccuracy bagging a chemical (25¢. per lb.), it would just about wipe out the savings. However, the \$0.009 speed-up saving would pay for about 1 lb. of material per bag in the mineral class (1¢. per lb).

3 Improve Accuracy

Accuracy improvements can be justified easily. Consider bagging a 5¢. per lb. material (feed) in 50 and 100-lb. bags at a rate of 12 per min. where the bagging scale accuracy is plus or minus 4 oz. Improving the accuracy 2 oz. would save \$4.50 per hr. (Figs. 1 and 2). This savings would justify an investment of \$13,000 for more accurate equipment, using the three-year amortization figures and the 52 percent tax.

Incidentally, the \$4.50-saving is equivalent to the labor cost of two men. Therefore, two 2-man bagging systems operating at 6 per min. at a 2-oz. accuracy are no more costly than two men doing 12 per min. with a 4-oz. accuracy.

4 Right Bag Type

If the operation is slow and the problem involves bag cost, the open-mouth bag is probably to be preferred. If bagging could be done with a non-tuck-in sleeve and a glued bag, the valve bag would be preferred.

The valve bag, although it costs more than the open-mouth bag, is less costly to handle. Requiring no closing operation, it allows one man to run a bagging installation. At bagging rates lower than 5 or 6 per min., however, one man can weigh-out and close open-mouth bags.

At higher rates the extra labor needed to close the open-mouth bags nearly balances the valve cost. If the difference in cost of the two bags, for instance, is \$0.007 at a bagging rate of 6 per min. the valve bag costs as much to use as the open-mouth unit (Fig. 3). The same applies when the difference is \$0.0018 and bagging rate is 20 per min. It takes careful study to find out which bag is best at high rates. An impartial bag supplier can make such a study best for you.

5 Sew Automatically

Before considering automatic sewing, you should be sure you are getting the best accuracy and the lowest bag cost.

An important thing to remember is that it is nearly impossible for an automatic sewing device to completely replace a sewing operator. Sewing heads require maintenance. Much of this maintenance is performed at manual installations by the sewing operator. He frequently oils the machine, repairs broken thread, adjusts the sewing head, besides performing general preventive maintenance service.

He is also an inspector; he sees when a thread breaks and holds up operation until repairs are made. Where a tape closure is involved, he fingers the top of the bag to make certain that the sewing passes through the tape and that it passes through the bag.

With automatic sewing, therefore, maintenance may become a problem. Automatic sewing certainly will not eliminate a full man. A more realistic figure would be "one-half of a man."

It is unlikely that automatic sewing can be had by eliminating one-half man. Based on a figure of \$4,500 a year, cost for one-half man amounts to \$2,250. For a three-year amortization and a 52 percent tax on profit, an investment of only \$3,300 can be justified, which is probably too small to buy the automatic sewing equipment.

Before reducing labor cost by installing automatic sewing, it pays to exploit the possibilities of better accuracy or reduced bag cost. For example, in bagging a commodity costing 5¢. per lb. at a rate of 12 bags per min., a ½-oz. accuracy improvement will save as much as automatic sewing.

It is probably more feasible to buy with the \$3,300 a ½-oz. accuracy improvement rather than automatic sewing equipment. Relative to bag cost, automatic sewing could easily require the use of larger bags to facilitate the automatic sewing operation. At 12 bags per min., a bag cost increase of \$0.0015 would cancel out a \$3,300 savings provided by automatic sewing.

On the other hand, where accuracy and bag cost are at the optimum and where speeds of say 20 per min., and a three-shift operation is involved, labor reduction could provide a saving. If two 2-man systems are required without automatic sewing, a saving of 2½ men on each shift is possible.

This saving would amount to \$33,750 per year. It would justify an investment of about \$53,000 on the basis of 3-year amortization and a 52 percent tax. Significantly, if the tonnage is high, automatic sewing can be important.

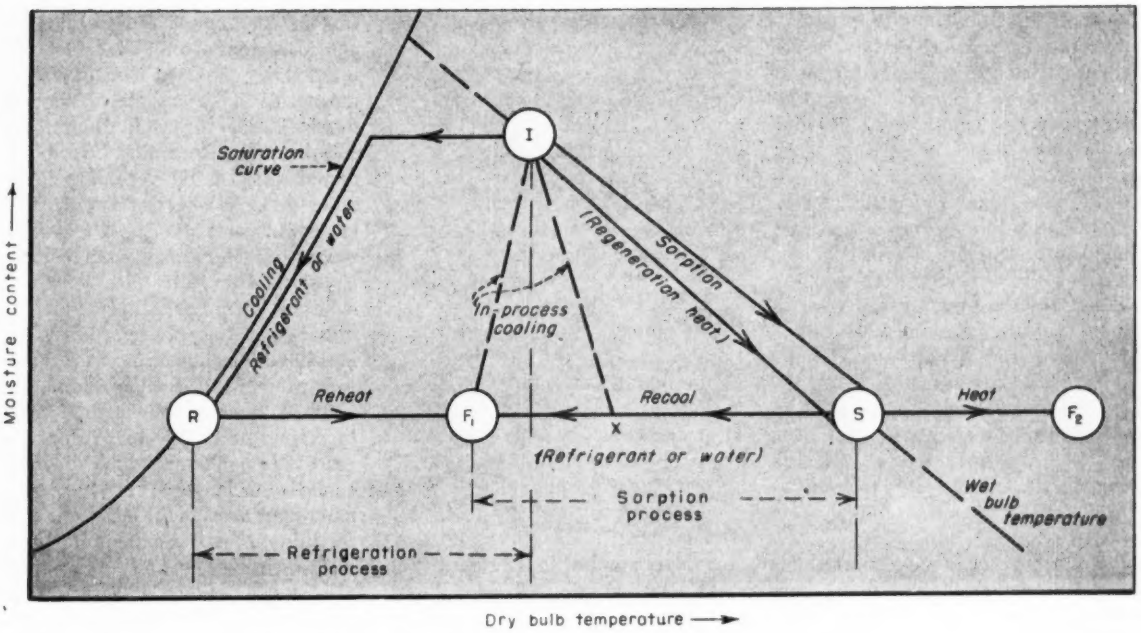


Fig. 1—How sorption and refrigeration-drying processes plot out on the psychrometric diagram.

Sorption in Gas and Air Drying

Only a thorough economic study and comparison can tell whether (1) cooling-condensation or (2) sorption will be best in any air or gas drying case. Here is help toward such a study.

FRANK. M. WATERHOUSE

You need air or other gases for process use. Why reduce and control the moisture content? You may do so for a variety of reasons, such as: (1) To provide supply air to a process or an air conditioned area; (2) to allow subsequent reuse of process gases; (3) to prevent frosting and clogging of low-temperature surfaces; and (4) to avert line plugs by gas hydrates.

Gas and air drying has developed along two broad lines; (1) Dehumidification by cooling, which has been well explored and widely applied; and (2) moisture removal by ab- or adsorption (sorption), which makes use of solid and liquid sorbents and depends on physical or chemical effects or combinations of these.

Depending on the equilibrium moisture for any particular sorbent (e.g., see Table II) sorption is capable of dehydrating gases and air almost completely; it warrants consideration on an economic basis in an increasing number of cases. Several well-developed "package" sorbers can be had for adjusting moisture to dew points as low as −20 deg. F., along with temperature control. Still lower dew points can be obtained but for these special engineering is needed in case of large volumes.

F. M. WATERHOUSE, *of Rochester, N. Y., is a mechanical engineer interested in development.* *This paper is based on one he presented under the title of "Use of Sorbents for Drying Process Gas and Air" before the Process Division of the ASME, New York, Dec. 4, 1953.*

PRINCIPLE OF OPERATION

In sorbent systems cooling is not essential to dehumidification. (Although final temperature adjustment may require it). Moisture in vapor form is extracted by taking advantage of the natural differentials in vapor pressure of water which exist between certain substances and airborne vapor. Contact with a sorbent agent causes the vapor to be taken up by the sorbent as water, releasing latent heat and heat of wetting or solution to both the air and the sorbent. The dry-bulb temperature of the air increases as a function of the moisture content reduction. Final temperature adjustment is essentially a separate stage, but is often combined with the sorption process by internal cooling which removes the latent heat as it is released,

rather than at the completion of drying. The water-loaded sorbent is finally reactivated or regenerated by heat and then cooled to operating temperature again to complete the sorption cycle.

Thus, from an economic standpoint, the sorber is a means of controlling moisture by using heat and high-level refrigeration, instead of the lower level mechanical refrigeration required in removing moisture by cooling. There are cases when this ability to choose between utilities is quite valuable and convenient.

Note that if refrigeration is used for simultaneous cooling and sorption, a dew-point temperature is achieved that is well below that corresponding to the refrigeration temperature. This means that the refrigeration suction temperature can be considerably higher for a given dew point, thus requiring less compressor power. Also, fewer tons of refrigeration may be required since the sensible-heat load is reduced. A supply of water is needed for greatest advantage, to recool the sorbent after regeneration. The power reduction may become a substantial figure in the region of 0 deg. F., and may be worthwhile at higher temperatures. This hybrid arrangement of dehumidifying by both refrigeration and sorption has its own best area of application.

Many substances, both liquid and solid, have sorbent properties, but relatively few have been developed with an adequate combination of efficiency and economy for general use. Four liquid sorbent-type dehumidifiers are available in packaged units, and about eight granular solid sorbents are used in a variety of packaged or well developed units.

APPLICATION

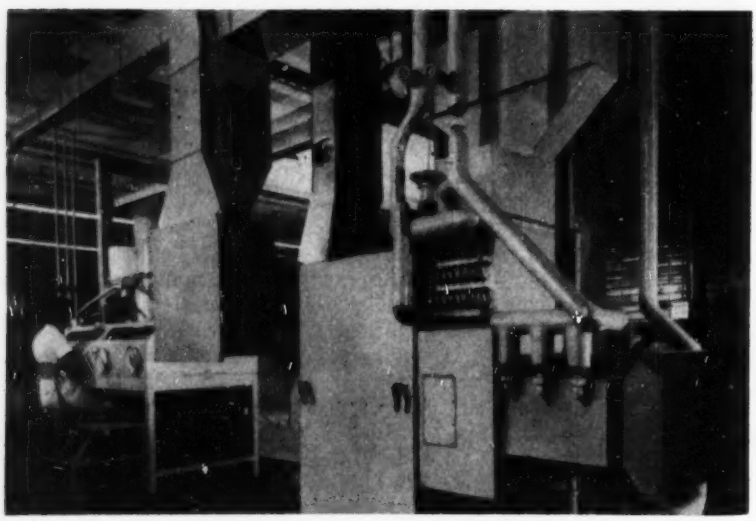
The optimum conditions of a sorption system for any set of relative values of heat and refrigeration are best explained on a psychrometric diagram. A characteristic chart of this type is shown in Fig. 1. Here dry-bulb temperature is the abscissa and weight of moisture per unit of gas or air is the ordinate. The vapor-saturation line slopes upwards to the right. Wet-bulb temperature lines slope downwards to the right. Lines of constant dew point are horizontal. Dehumidification processes are shown as chopped-off triangles on this chart. Sorption conditioning is represented by the right side of the figure. Gas or air at initial condition *I* is dehumidified and heated by sorption through a series of conditions represented by *I-S*, the general path of the wet-bulb lines. This is shown as an indefinite path, as the process is not necessarily adiabatic, being influenced by the heat of wetting or solution of the given agent and absorption of heat by the sorbent body. The condensed moisture subsequently must be evaporated by heat to reactivate or regenerate the sorbent and the sorbent then must be recooled by water, gas, or air, to commence another cycle. Liquid sorbents require low-level heat (230 deg. F.) for regeneration; solid sorbents require high-level heat (300 to 600 deg. F.).

Temperature adjustment of the dried gas or air proceeds along the horizontal base line of the figure. Sensible cooling to the final condition at point F_1 requires only high-level refrigeration effect (60 to 85 deg. F.) near the high-temperature or right-hand end of line *F-S*, but will require lower-level mechanical refrigeration as condition F_1 is lowered in temperature. Sensible heating to point F_2 usually can be done with steam, the pressure required depending on temperature F_2. The dotted line *I-x* represents cooling simultaneously with sorption and is achieved by using either a sorbent at low temperature at the start of the cycle, or by cooling coils (water or refrigeration) within the body of sorbent during the cycle. If desired, simultaneous cooling to final condition F_1 is often possible, as shown by dotted line I-F_1.

For comparison, dehumidification by cooling is represented by the left side of the figure. High-level refrigeration usually suffices near point *I*, as in cool water-spray washers. However, as temperature at point *R* is lowered, lower-level refrigeration is required, as in surface coolers and wet-coil coolers. Sensible heating (along the base of the figure) is usually by low-level heat, such as low-pressure heating steam.

Machines are available to process gas or air along each of the lines of the figure. Sorption machines use water as the coolant, and steam, gas or electricity as heat. Simultaneous cooling directly to the final condition (F_1) represents a hybrid process and appears to be the design basis for at least two liquid-sorbent machines, which combine refrigeration coils with sprayed sorbent in a single chamber.

The economic choice between various types of machine that could be used for any gas or air-conditioning



SOLID: Lectrodryer of air conditioning type uses activated alumina to produce low dew-point air for ampoule-filling cabinets (Pittsburgh Lectrodryer Corp.).

project depends on the relative positions of initial and final conditions in the diagram, the relative costs and availability of the various utilities (which vary widely), and the operating characteristics of the individual machines within the required range.

Factors which tend to favor sorbers are as follows:

1. An inexpensive and ample supply of water in the range of 60 deg. F., available to absorb the sensible-heat load of the process gas or air.

2. Little or no sensible heat load, as in cases of supplying high-temperature process gas or drying air, or where there is indifference to the final temperatures.

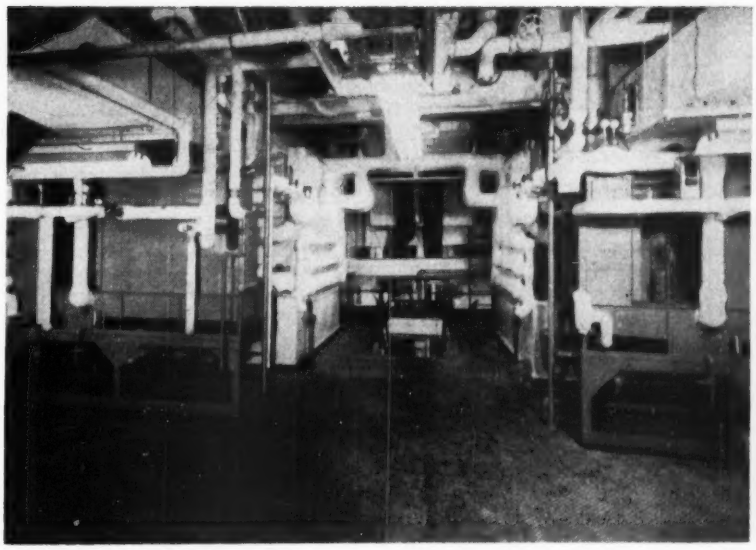
3. Low-cost steam for regeneration, particularly if mechanical refrigeration or electricity are high in cost. A high cost of electricity, translated to a high cost of refrigeration, reduces the competitive position of cooling conditioners using a combination of cool water and mechanical refrigeration.

4. High moisture load on the apparatus. These cases magnify the differentials in costs of utilities, usually tending to favor the sorber.

5. If conditioning is to be in the range of 0 deg. F., mechanical refrigeration is of course required. However, it may be used for cooling simultaneous with sorbent drying. Power requirements will be less than those for dehumidification by refrigeration alone, the difference being that the sorber reduces moisture to a given dew point at a higher dry-bulb temperature, thus using less refrigeration power. At low temperatures, this can be significant.

Sometimes special conditions must be considered. For example, it is possible for the process gas to be catalyzed by certain sorbents; and effect on the process or work area of vapors from some liquid sorbents must be considered. Where more than one type of vapor is present, there may be a preferential action of the sorbent. It is possible that there may be extraction by sorption of chemical condensates that are harmful to the sorbent agent or system. These factors should not be overlooked; perhaps they can be controlled or eliminated by selection of a proper sorbent agent.

For preliminary thinking, we may use the following broad generalizations of utilities consumption by sorbent systems. These figures are not adequate for firm evaluations of various systems (which should be made on the basis explained in the foregoing); they merely illustrate the general economic field of sorber application.



LIQUID: Two Kathabar units, part of a group of six, operate on lithium chloride with refrigeration to make 0 deg. F. process air (Surface Combustion Co.).

1. Regeneration of the sorbent may require 2-4 lb. of steam, or the equivalent electricity or gas, for each pound of moisture removed. Various units require up to five times this quantity of heat, depending on design.

2. Recooling of the sorbent requires 2-6 gal. of cooling water (or more) per pound of extracted moisture depending on water temperature and design of the sorber, unless air is used for this purpose.

3. Sensible cooling or heating is the same as with other processes.

4. Dehumidifying at constant dry-bulb temperature (a case of cooling simultaneously with sorption) requires 10-20 gal. of water per pound of moisture extracted (or more), depending on water temperature, design of the sorber and auxiliary use of air cooling.

5. Power required for mechanical refrigeration, when used for cooling along with sorbent drying, will be less than that for dehumidification by refrigeration alone. However, the cost of heat for regeneration of the sorbent must be balanced against this saving.

6. In some cases of combined temperature and humidity control it appears economical to over-dehumidify a small quantity of air, to dispose of the latent heat load; and subsequently to mix with a large volume which is cooled at a higher temperature to dispose of the sensible heat load.

Sorption machines are made in two basic types, one using a liquid absorbent in a spray chamber or scrubber, and the other a bed of granulated adsorbent through which the gas or air is passed.

LIQUID SYSTEMS

The liquid-sorbent system is shown schematically in Fig. 2. The numbered components are explained as follows:

1. A spray contactor or a bubble-tray tower which is supplied with the sorbent solution. The process gas or air is conditioned (loses moisture) in this chamber.

2. A regenerator wherein the diluted sorbent is dehydrated by evaporation. This may be a spray contactor or a reboiler. Those manufacturers who use spray-contactor conditioning chambers have elected to use comparable spray contactors for regeneration. Reboilers are used with bubble-tray conditioning towers in equipment

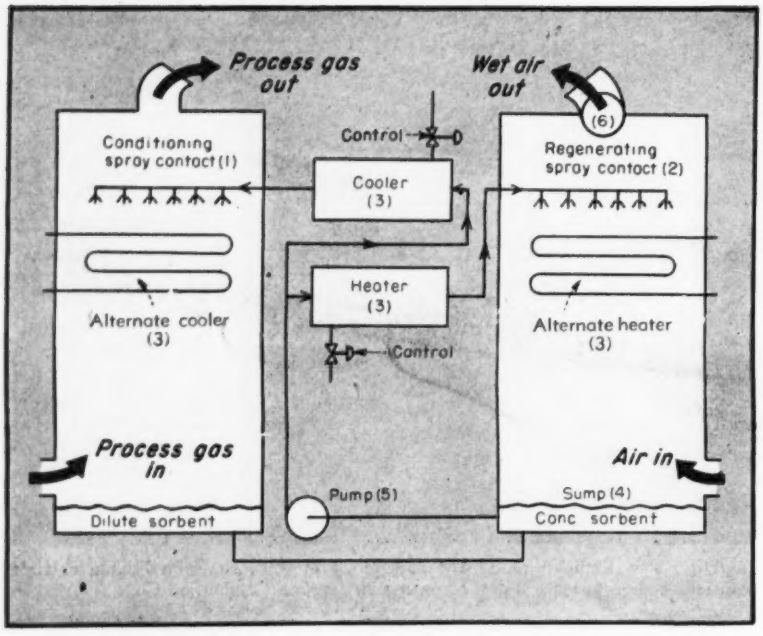


Fig. 2—Liquid sorbent machines use solutions such as lithium chloride and glycols, condition gas in contactor (1), regenerate solution in contactor (2).

intended for high-pressure gas-field work.

3. Heat exchangers to control sorbent temperatures. The sorbent is cooled for contact with the process gas or air on the conditioning side of the system and heated for contact with regenerating air on the regenerating side of the system. The heat exchangers may be external, e.g., shell-and-tube type, or they may be coils within the spray-contact chambers. Low-pressure steam is usually used in both the spray-contact regenerators and in the reboilers just referred to.

4. A storage sump for reserve sorbent.

5. Pumps to circulate the sorbent. The conditioning side of the system usually is arranged as the main flow circuit with a smaller parallel flow of sorbent through the regenerator. One or more pumps will be used, depending on the arrangements of the apparatus and selection of control equipment. Equipment intended for high-pressure gas-field work is designed to pump the sorbent through only one closed-circuit series of bubble-tray tower and regenerator.

6. A blower is required to ventilate the spray-contact type of regenerator. The foregoing items are not necessarily a unit assembly, and may be spread widely if convenient. One regenerator can be selected to serve several contact chambers if desired.

Control of delivered moisture content and dry-bulb temperature is by adjustment of sorbent contact temperature and concentration of the sorbent liquid. External adjustment of dry-bulb temperature also may be necessary in some cases. In comfort air conditioning, for example, it may be desirable to use several external coolers at different locations and at varying temperatures, so as to follow varying heat-load patterns.

Standard equipment is produced in capacities from 1,500 cfm. to 23,000 cfm. at low pressures, and to 40,000 std. cfm. at pressure ranges up to 100 psig. These machines are manufactured by several companies. See, for example, Table I.

Lithium chloride solution is used as the sorbent agent by one manufacturer. The solution probably also contains a small amount of sodium chromate to minimize corrosion and possibly some agent to control sludging. Occasional replacement of the sorbent is necessary to prevent scale and sludge. These machines control spray-contact temperature by either an internal or external heat exchanger. Lithium chloride solution is a highly efficient and adaptable sorbent, having favorable characteristics over a wide range of temperature and concentration. It does involve considerations of corrosion control and care must be taken to prevent loss of spray from the unit. Foreign substances should be filtered out of the gas or air stream and special selection of construction materials may be necessary.

Glycol solutions are used as sorbents by two manufacturers. One recommends triethylene glycol, and has designed equipment for heavy-duty, high-pressure work which does not depend greatly on precise temperature and dew-point control. A bubble-plate tower is used for simplicity of design.

Table I—Information Sources on Sorbent Dehumidifiers

(Following firms, among others, have bulletins on sorption equipment.)

Liquid Sorbents

Black, Sivalls & Bryson, Inc., Kansas City, Mo.
Niagara Blower Co., New York, N. Y.: Hygrol system.
J. F. Pritchard Co., Kansas City, Mo.
Surface Combustion Corp., Toledo, Ohio: Kathabar system.

Solid Sorbents

Affiliated Gas Equipment, Inc., Bryant, Ind. Div., Cleveland, Ohio.
Black, Sivalls & Bryson, Inc., Kansas City, Mo.
Davison Chemical Corp., Baltimore, Md.
Desomatic Prod. Div., Daly, Merritt & Sullivan, Falls Church, Va.
General Air Conditioning Corp., Cincinnati, Ohio.
Girdler Corp., Gas Process Div., Louisville, Ky.
W. A. Hammond Drierite Co., Xenia, Ohio.
Industrial Corp., East Roselle Pk., N. J.
H. J. Kaufman Co., Detroit, Mich.
C. M. Kemp Mfg. Co., Baltimore, Md.
National Tank Co., Tulsa, Okla.
Pittsburgh Lectrodryer Corp., Pittsburgh, Pa.
J. F. Pritchard Co., Kansas City, Mo.
Selas Corp. of America, Philadelphia, Pa.

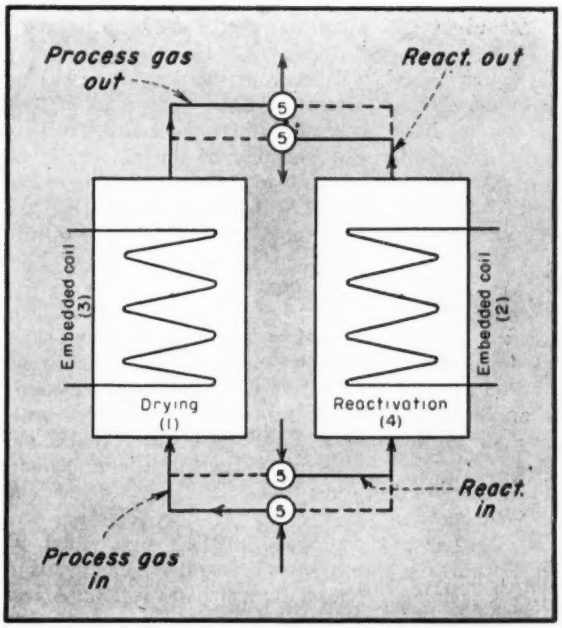


Fig. 3—Usual solid sorbent machine has two vessels for continuous use, one operating, one regenerating at all times.

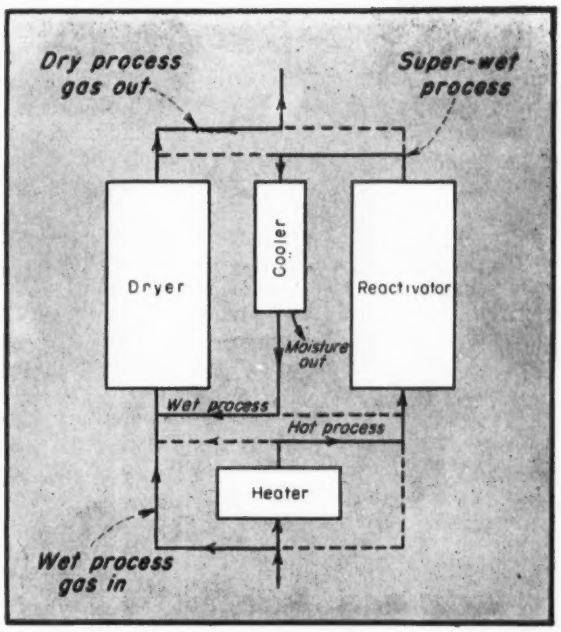


Fig. 4—Special hookup of solid sorbent machine used when process stream must not be contaminated by regenerant gas.

The second concern supplies a solution of unrevealed formula, perhaps a different glycol with additives to increase efficiency. This manufacturer has designed machines to adjust the spray-contact temperature with cooling coils inside the contactor. The coolant can be water, brine, flooded ammonia or direct-expansion refrigeration. All glycol solutions have a slight evaporative loss in operation, at least part of which will be picked up by the process gas or air. Viscosity of solutions concentrated enough for sorbent use appears to be impractically high at very low temperatures.

Special equipment can be designed to suit certain processes. Various organic liquids, sulfuric acid and several salt solutions have optimum characteristics for given applications. It should be noted that some of these liquids have rather toxic fumes while others are expensive. The salts in general are corrosive, and may not give a suitable combination of efficiency and solubility characteristics at desired temperatures.

SOLID SYSTEMS

The solid-sorbent system is shown schematically in Fig. 3. The numbered components are explained as follows:

Drying takes place in trays or deep beds of granular sorbent (1) through which the process gas or air is passed. The sorbent becomes saturated with moisture and is reactivated by passing hot gas or air, or combustion gas, or by heating with embedded steam coils (2) or electric elements. The sorbent is cooled before service by cycling air or process gas through the bed, or by flowing water through the embedded coils (3), or both. Cycles normally are between 6 and 24 hr. in length. Continuous supply is provided by arranging sorbent beds for alternate use in each phase of the cycle (1) and (4) Smooth automatic transition is achieved by time-switch controls (5), or by mechanical design of the machine.

The degree of drying obtained depends largely upon the characteristics of the sorbent used and the relative depth of the bed. Flexible control of delivered moisture content can be obtained either by recycling a portion of the process gas or air to lower the dew point, or by bypassing a portion to raise the dewpoint.

Process work may require control of the sorbent temperatures at a low level, obtained by circulating coolant in embedded coils (3) to stabilize the action and prevent temperature rise due to heat of moisture condensation and sorbent wetting.

NON-CONTAMINATING SYSTEM

For cases where a different reactivating gas such as air must not get into the process gas system, the reactivating method shown schematically in Fig. 4 is used in present designs. This procedure consists in reactivating the sorbent with a heated portion of wet process gas which is subsequently cooled to precipitate the excess moisture. This gas rejoins the process stream and enters the operating sorbent bed. This appears economical for very wet gas. In other cases, the system is scavenged by raw process gas which is subsequently discarded.

Standard equipment is made in capacities up to 15,000 cfm. at low pressures and up to 35,000 std. cfm. at pressure ranges to 5,000 psi. In general, each manufacturer prefers one sorbent agent exclusively, but many sorbents are available.

One design of solid-sorbent dehy-

drator intended for industrial use consists of deep beds in two parallel towers. Cooling coils may be imbedded in the sorbent to protect against overheating in service, or to stabilize action. Reactivation requires steam, electricity, or gas; the cooling coils can also be used for steam if desired.

Another design for high-pressure use in gas fields has compartmented beds arranged in tandem horizontal cylinders. Reactivation is by heat produced by gas combustion and transferred to a portion of the process gas which is cycled through the saturated bed, cooled and scrubbed, and returned to the process system.

There are two designs of packaged units intended for drying air in substantial quantities. One, with capacities up to 15,000 cfm., has a number of beds and a rotating-port valve directing supply air and heated air for reactivation to the proper beds; a coil is provided for aftercooling or heating, and fans and motors are built in. Another machine, with capacities up to 3,000 cfm. has a cylindrically shaped bed of sorbent in continuous rotation. One side of the cylinder dehumidifies supply air while the other side is being reactivated by heated air. Gas, electricity, or 100-psig. steam is used for reactivation in either of these machines.

Several useful solid sorbents are listed in Table II, with data on their efficiency ratings. For those most used there is supplementary information on minimum dew-point temperatures possible, and other characteristics, and trade names.

"Efficiency" in the table is defined by the Bureau of Standards as the minimum weight of air moisture at equilibrium with the sorbent, expressed as milligrams of water per liter of air. This can be translated to minimum dew points obtainable. Capacity is the weight of water sorbed per unit weight of the sorbent, expressed as percent dry basis. Operating capacities depend on the sorbent used, the relative humidity of the gas or air in process, and the temperature of operation; a normal design capacity appears to be about 5 or 7 percent, with a maximum of perhaps 20 percent in some cases.

There are a few other sorbents than those listed in Table II whose characteristics migh be desirable in some cases. For example, the most efficient of all sorbents is phosphorous pentoxide, P_2O_5, which is strongly acid and otherwise difficult to handle. Barium oxide, BaO, is almost as efficient (−111 deg. F. dew point), is safe and easily handled, but cannot be regenerated. It will dehumidify up to temperatures of 1,000 deg. F. (Amero *et al, Chem. Eng. Progress*, **43**, 349 1947).

To sum up, a sorber is essentially a moisture extraction machine which finds its best application where the latent heat load is large compared to the sensible heat load. Since the latent heat is converted to sensible heat at a higher temperature level, higher temperature coolants can be used to advantage. However, in any case, the application must be studied to find whether humidity and temperature control can be handled better by sorption, by mechanical refrigeration, or by a combination of the two. Which type is economically justified will largely be determined by the relative cost and availability of water and heating steam, compared with electricity.

As between types of sorbents: (1) Liquid sorbers can use low-level heat for regeneration, whereas solid sorbers must have high-level heat. (2) Solid sorbers are simple in design and operation, but (3) the liquid sorber is more compact and its components may be separated—widely if desired. Solid sorbers are bulkier, but likewise self-contained. (4) Liquid sorbents are easier to clean and to replace if process contamination should occur. And (5) the liquid sorber can humidify—rather than dehumidify—if needed for control purposes.

Table II—Solid Sorbents and Their Efficiencies

(Those for which dew points and remarks are included are the ones in most common use.)

Substance and Formula	Efficiency, Mg./Liter[1]	Min. Dew Point, Deg. F.	Remarks and Trade Names
Barium oxide, BaO	0.00065	−111	Effective to 1,000 deg. F. but cannot be regenerated.
Magnesium perchlorate, anhyd., $Mg(ClO_4)_2$	0.002	−98	An absorbent; works by forming hydrate. Can be damaged by water soaking or overheating. Can form an explosive in acid-bearing gas or air. Name: Anhydrone
Calcium oxide, unglazed, CaO	0.003	....	.....
Calcium sulfate, anhydrous, $CaSO_4$	0.005	−87	An absorbent. Can be damaged by water soaking or overheating. Name: Drierite.
Activated alumina, Al_2O_3	0.005	−87	An adsorbent. Withstands abuse and overheating. Name: Hydralo.
Potassium hydroxide (sticks), KOH	0.014	−72	An absorbent. Corrosive. Often used in static dehydrators.
Activated bauxite	.....	....	An adsorbent containing about 67 percent Al_2O_3. Inexpensive, withstands abuse. Performance depends on specific composition. Names: Driocel Florite, Porocel, Attapulgus clay.
Silica gel, SiO_2	0.030	−61	An adsorbent. Withstands abuse and water soaking. Names such as Sova-Bead, Protek-Sorb.
Magnesium perchlorate, trihydrate, $Mg(ClO_4)_2 \cdot 3H_2O$	0.031	−60	An absorbent; same precautions as above. Name: Dehydrite.
Calcium chloride, anhydrous, $CaCl_2$	0.36	−21	An absorbent, often used in static dehumidifiers. Sometimes mixed with other sorbents to increase saturation capacity. Name: Calorids (as blocks).
Sodium hydroxide (sticks), NaOH	0.80	−5	An absorbent. Inexpensive, corrosive.
Barium perchlorate, anhydrous, $Ba(ClO_4)_2$	0.82	−4	An absorbent. Name: Desicchlora.
Others[2]			

[1] From J. H. Bowser, U. S. Bur. Standards *J. Research*. R. P., No. 649 (1934), p. 246. Note effy. units are mg. water per liter air at equilibrium.

[2] Compound and efficiency $ZnCl_2$ (sticks), 0.98; $CaCl_2$ (tech. anhyd.), 1.25; $CaCl_2$ (granular), 1.5; $CuSO_4$ (anhyd.), 2.8.

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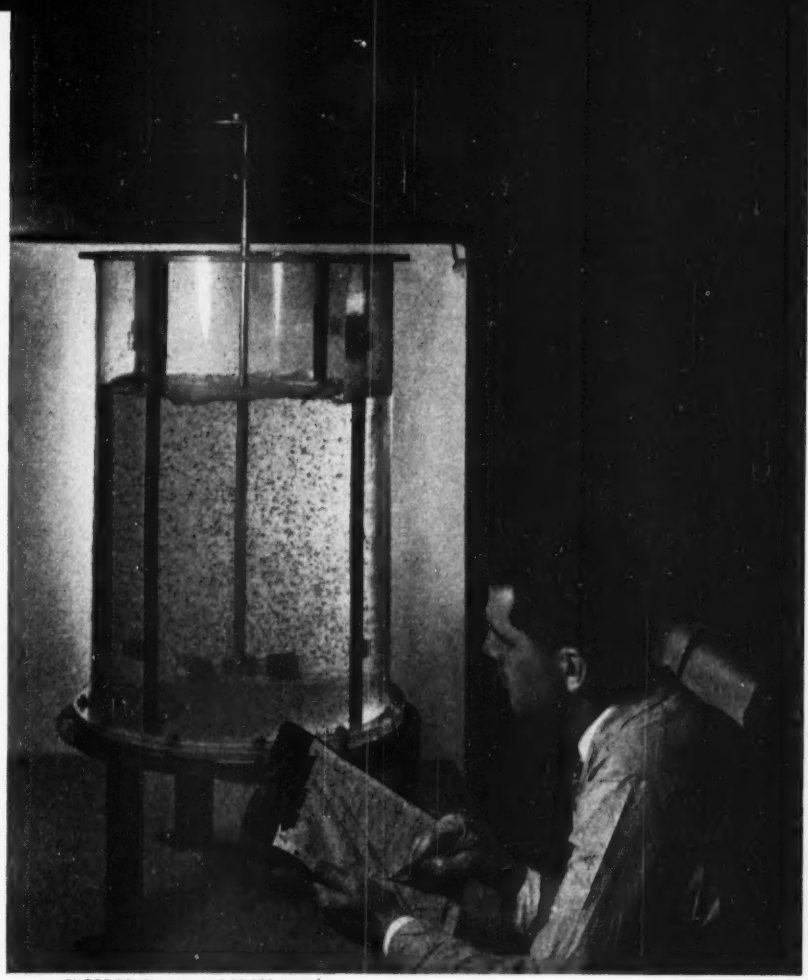

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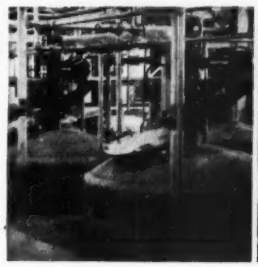

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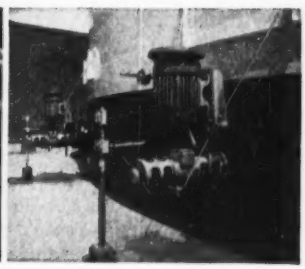

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Chemical Engineering Fundamentals

Chemical Equilibrium—IV

THOMAS E. CORRIGAN, Research Engineer, Mathieson Chemical Corp., Brandenburg, Ky.

Our discussion of chemical equilibrium in previous installments (*Chem. Eng.*, Mar. 1954, p. 222; Apr. 1954, p. 212; and May 1954, p. 202) considered chemical reactions and energy effects accompanying them. We discussed the significance of equilibrium constants and their use to find out how far a reaction will go. The cases covered included homogeneous single reactions, adiabatic reactions and simultaneous homogeneous reactions.

In this concluding installment on chemical equilibrium our topics will be the effect of dissociation on the calculation of theoretical flame temperatures and some explanations about standard states.

Theoretical Flame Temperatures

A previous section (*Chem. Eng.*, Mar. 1954, p. 230) explained that in calculating a theoretical flame temperature we assume that the combustion process is so fast that there is no time for the heat to be transferred away from the flame.

Then the process is adiabatic and all the energy released is absorbed by the products.

The theoretical flame temperature is the temperature at which the products of combustion leave an adiabatic process. If the effect of dissociation is neglected, then calculated theoretical flame temperatures differ from measured ones by less than 10 percent. There are some engineering applications where further refinement is desired and we include the effect of dissociation.

Effect of Dissociation

At the high temperatures involved in flames there is bound to be some dissociation of the products of combustion, steam and carbon dioxide, into their elements Thus,

$$H_2O\ (g) \rightleftarrows H_2\ (g) + \tfrac{1}{2}\,O_2\ (g)$$
$$\Delta H = 57{,}800 \text{ cal./gm.-mole}$$

and,

$$CO_2\ (g) \rightleftarrows C\ (s) + O_2\ (g)$$
$$\Delta H = 94{,}030 \text{ cal./gm.-mole}$$

or the reaction might be,

$$CO_2\ (g) \rightleftarrows CO\ (g) + \tfrac{1}{2}\,O_2\ (g)$$
$$\Delta H = 67{,}410 \text{ cal./gm.-mole}$$

The elements, hydrogen and oxygen, may also dissociate into atomic hydrogen and oxygen as follows:

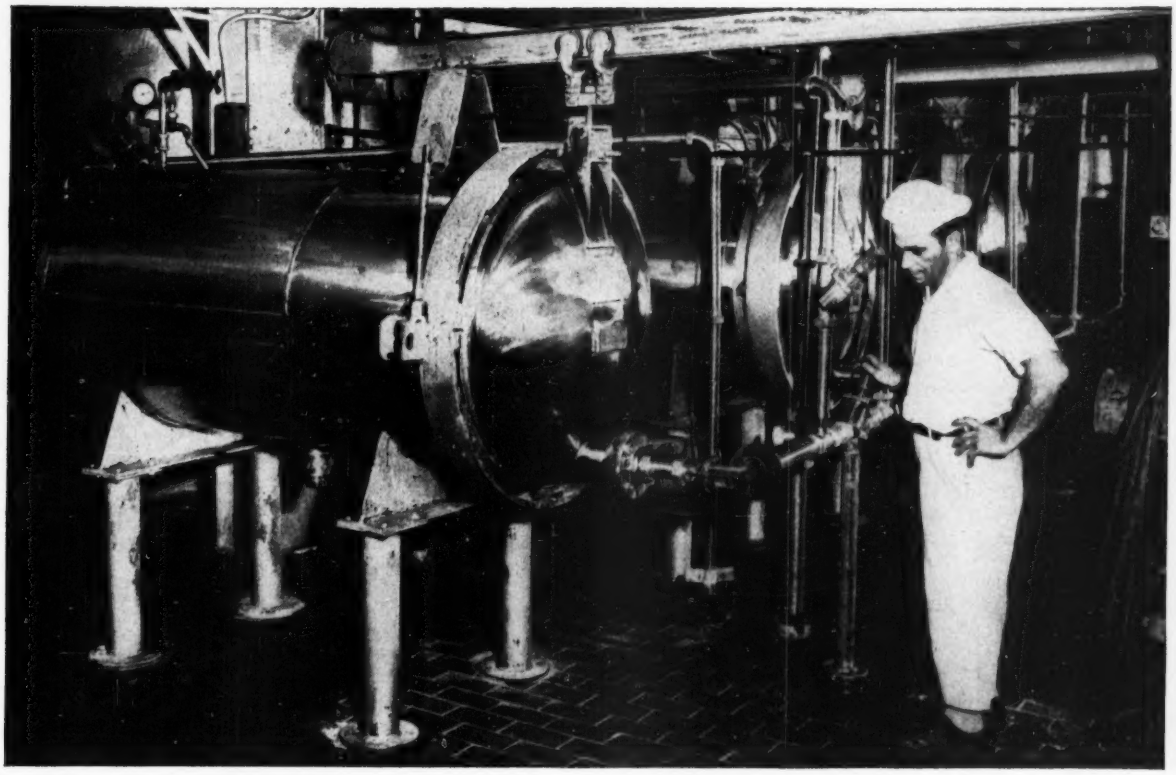
$H_2 \rightleftarrows 2H$ $\quad \Delta H = 103{,}000$ cal./gm.-mole
$O_2 \rightleftarrows 2O$ $\quad \Delta H = 117{,}500$ cal./gm.-mole

All of these reactions will be at equilibrium and the equilibrium constant of each varies with temperature, the unknown which we are endeavoring to calculate. Each of these reactions absorbs energy and hence tends to lower the actual flame temperature.

A method of calculating the corrected flame temperature is, first, to take the uncorrected temperature and look up the equilibrium constants (at that temperature) for the above reactions. From this, calculate the degree of dissociation of the H_2O and the CO_2 and the energy absorbed by the dissociation. This energy is then subtracted from the total energy term in the equation,

Nomenclature (Consistent units)

a	Activity
(aq)	In aqueous solution
A,B,R,S	Components in a reaction
C	Concentration
C_p	Heat capacity at constant pressure
f	Fugacity
f°	Fugacity in some specified state
$f^{o\prime}$	An arbitrarily defined fugacity (see p. 248)
(g)	Standard state, gaseous
ΔH	Heat of reaction
ΔH°	Heat of reaction in some specified state
ΔH_c°	Heat of combustion, specified state
ΔH_f°	Heat of formation, specified state
ΔH_S	Heat of reaction at standard temperature T_S
K	Equilibrium constant
K_c	Equilibrium constant, concentration basis
K_m	Equilibrium constant, molal basis
m	Molality
p	Pressure
(s)	Standard state, solid
S	Entropy
S°	Entropy in some specified state
T	Absolute temperature, deg. K. or deg. R.
T_S	A standard temperature
x	Mole fraction
γ	Activity coefficient
Σ	Summation of
Additional Subscripts	
A,B,R,S	Of component A, B, R, S, etc.
P	Of the products
R	Of the reactants



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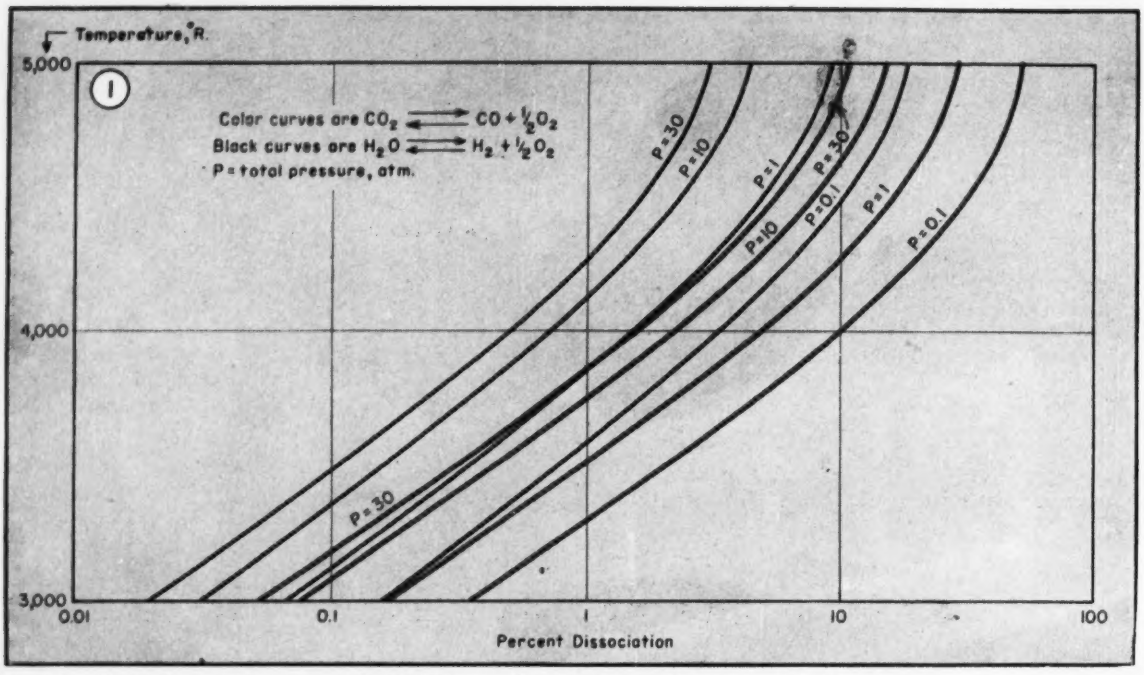

Significant dissociation at high temperatures should be considered in flame temperature calculations.

$$\int_{T_R}^{T_2} \Sigma\,(C_p)_P dT = -\Delta H_S - \int_{T_S}^{T_1} \Sigma\,(C_p)_R dT$$

and a new temperature is calculated.

The procedure is repeated using the equilibrium constants at the new temperature. The calculation is then continued until two temperatures are arrived at within the desired limits of error. Usually not more than two trials are required.

Charts have been prepared showing the degree of dissociation of H_2O and CO_2 as a function of temperature. Their use facilitates flame temperature calculations where the effect of dissociation is significant. Fig. 1 is such a chart, prepared from data found in "Fuels and Combustion" by M. L. Smith and K. W. Stinson, McGraw-Hill Book Co., Inc., New York (1952).

Standard States

Probably one of the most confusing points in chemical reaction equilibria is the use of standard states. This concept is most confusing in the case of reactions in which one or more of the components are in solution.

In the case of gas reactions the standard state is unit fugacity and therefore the proper term to use in the equilibrium equation is the fugacity of each gas (the partial pressures if the gases are ideal).

For example, in the reaction

$$CO + \tfrac{1}{2}O_2 \rightleftarrows CO_2$$
$$K = p_{CO_2}/p_{CO}\,(p_{O_2})^{1/2}$$

Where pure solids or pure liquids are involved, the fugacity of each in the reacting system is practically the same as in the standard state and the activity term becomes unity. For example, in the reaction

$$C + O_2 \rightleftarrows CO_2$$
$$K = p_{CO_2}/p_{O_2}$$

In the case of solutions, however, the proper term to use in the equilibrium equation, even for the case of ideal solutions, would depend for each component upon the standard state used for that component in the calculation of K. If the standard state for each constituent in the solution were the pure substance at the temperature and pressure of the system and if the solution were ideal, the equilibrium equation would be used with mole fractions as concentration terms. For the reaction

$$A + B \rightleftarrows R$$

in an ideal solution,

$$K = x_R/x_A x_B$$

If the standard state of B were the pure component at the temperature and pressure of the system and that of A and R were a one molal solution of an ideal solution, the equation would become

$$K = m_R/m_A x_B$$

In the case of the non-ideal solution, the standard state becomes even more complicated. A plot of f versus x is a straight line for an ideal solution (See Fig. 2a). When $x = 1.0$, $f = f^\circ$ and when $x = 0$, $f = 0$. The equation for this relationship is

$$f = f^\circ x$$
$$a = f/f^\circ = f^\circ x/f^\circ = x$$

or the activity is equal to the mole fraction.

But in the case of the non-ideal solution a plot of f vs. x is curved as shown in Fig. 2b.

Fig. 2b shows that f does not equal $f^\circ x$. Therefore, since $a = \gamma x$, γ must vary with composition. At the extreme left of the graph (where x approaches zero) the

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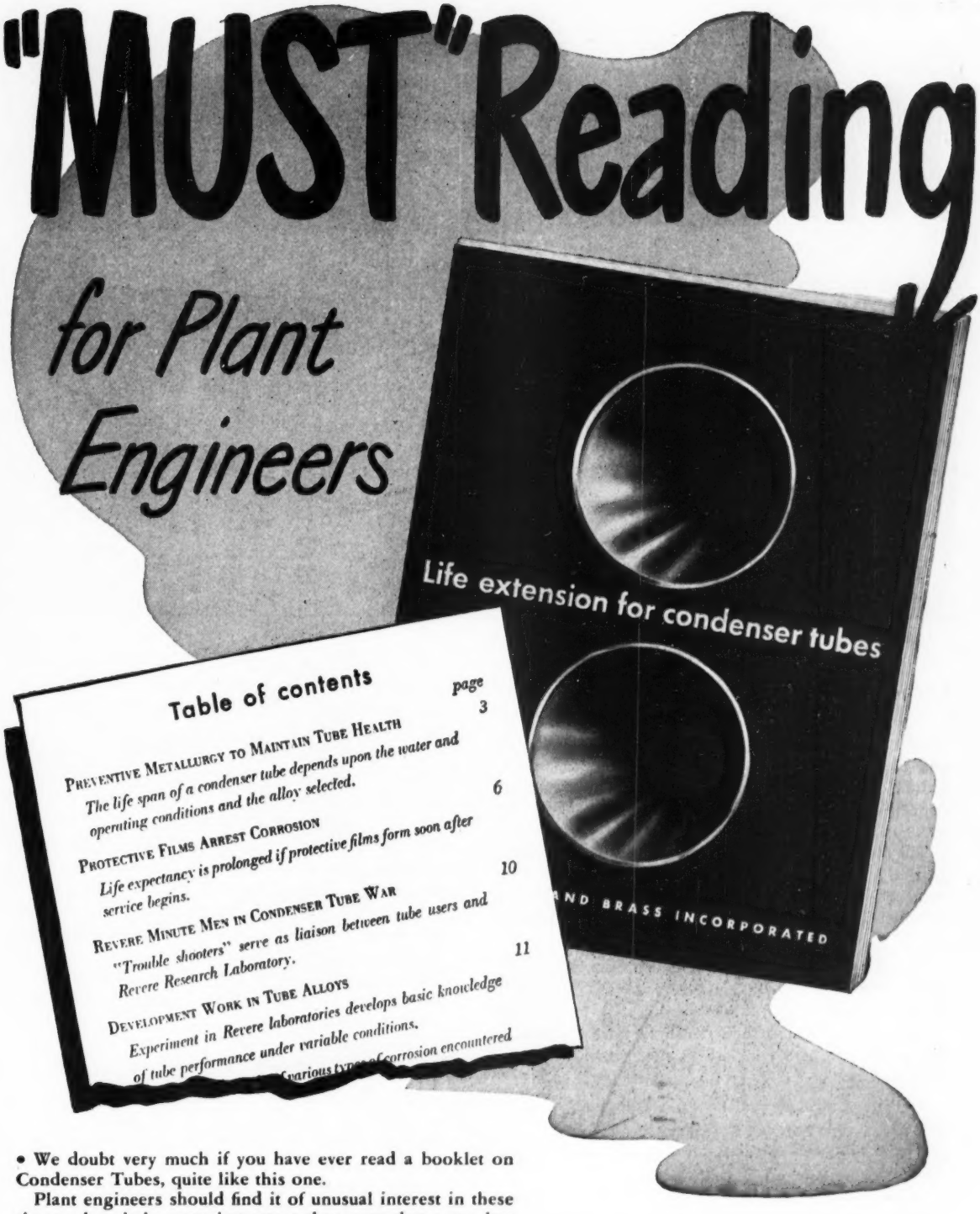
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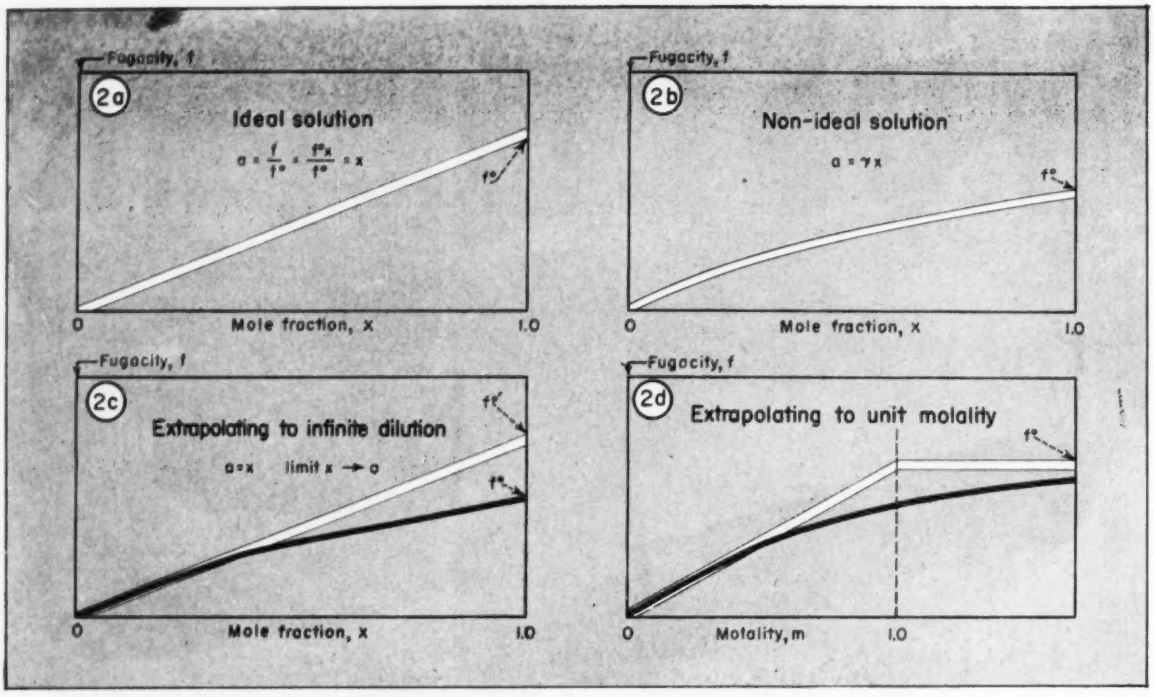

solution behaves ideally. At low values of x, we find

$$f = f^{\circ}x.$$

Therefore, the f vs. x curve starts out as a straight line and the curvature does not begin until a finite concentration is reached. An arbitrary standard state may be defined by extending the straight line portion of the curve as we have done in Fig. 2c.

The straight portion of the f vs. x curve is extrapolated to $x = 1.0$. This locates an arbitrarily defined standard state, $f^{\circ\prime}$ such that gamma approaches one at infinite dilution. This standard state is defined mathematically as

$$a = x \qquad \text{limit } x \to 0$$

Another arbitrary standard state can be defined by plotting f vs. m (molality) and extrapolating the straight portion to unit molality as shown in Fig. 2d. If this standard state is used then molalities must be used in the equilibrium equation instead of activities. Then for the reaction.

$$CaCO_3\,(s) \rightleftarrows Ca^{++}\,(aq) + CO_3^{--}(aq)$$

$$Km = (mc_a{}^{++})\,(mco_3{}^{--})/1$$

The equilibrium constant for this case is sometimes called the ion product constant. Still another standard state may be used. Here the curve is extrapolated to unit concentration (expressed as moles per liter).

If this standard state is used, concentrations must be used in the equilibrium equation. For the reaction above, the equation would be:

$$Kc = (Cc_a{}^{++})\,(Cco_3{}^{--})$$

It should be emphasized again that in an equilibrium calculation the standard state can not be chosen arbitrarily. It is usually specified in the tables which list the standard heat of formation, ΔH°_f, or standard heat of combustion data, ΔH°_c, and S° data. One must be sure that he uses the standard states specified by the tables from which he obtains the data. It is also important that the standard state specified in the enthalpy and entropy tables is consistent for each component.

Review and Preview

The subjects in CE REFRESHER up to now were presented to give the practicing chemical engineer a brief review of some of the fundamental concepts of thermodynamics and its applications to chemical engineering. The material by no means was meant to cover completely the wide scope of the subject. The broad fields involving the applications of thermodynamics principles to physical changes (such as separation processes) and to such mechanical engineering problems as refrigeration have not been covered. These will be considered at a later date if there is sufficient demand. We welcome your suggestions.

Next month we plan to begin our discussion of applied reaction kinetics and the application of these principles to the solution of practical engineering problems.

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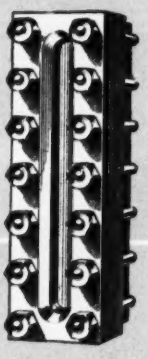

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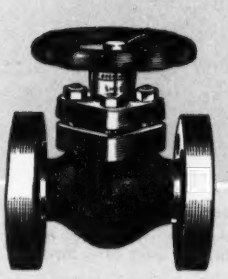

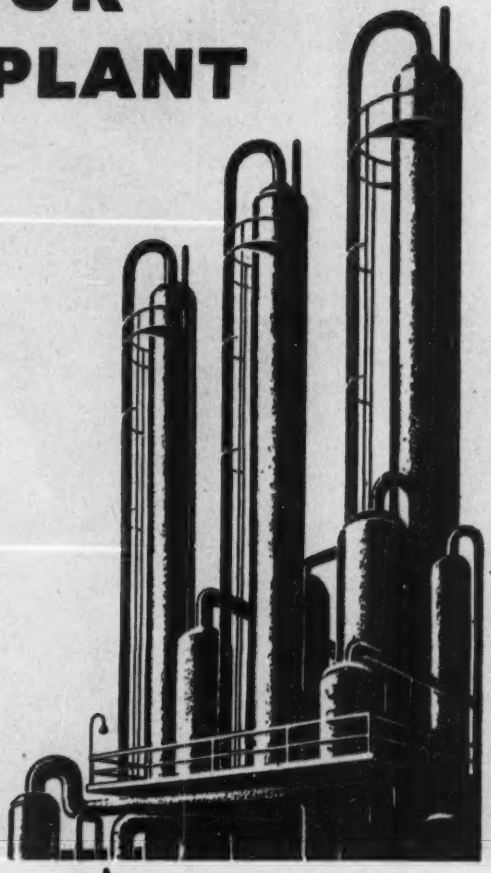

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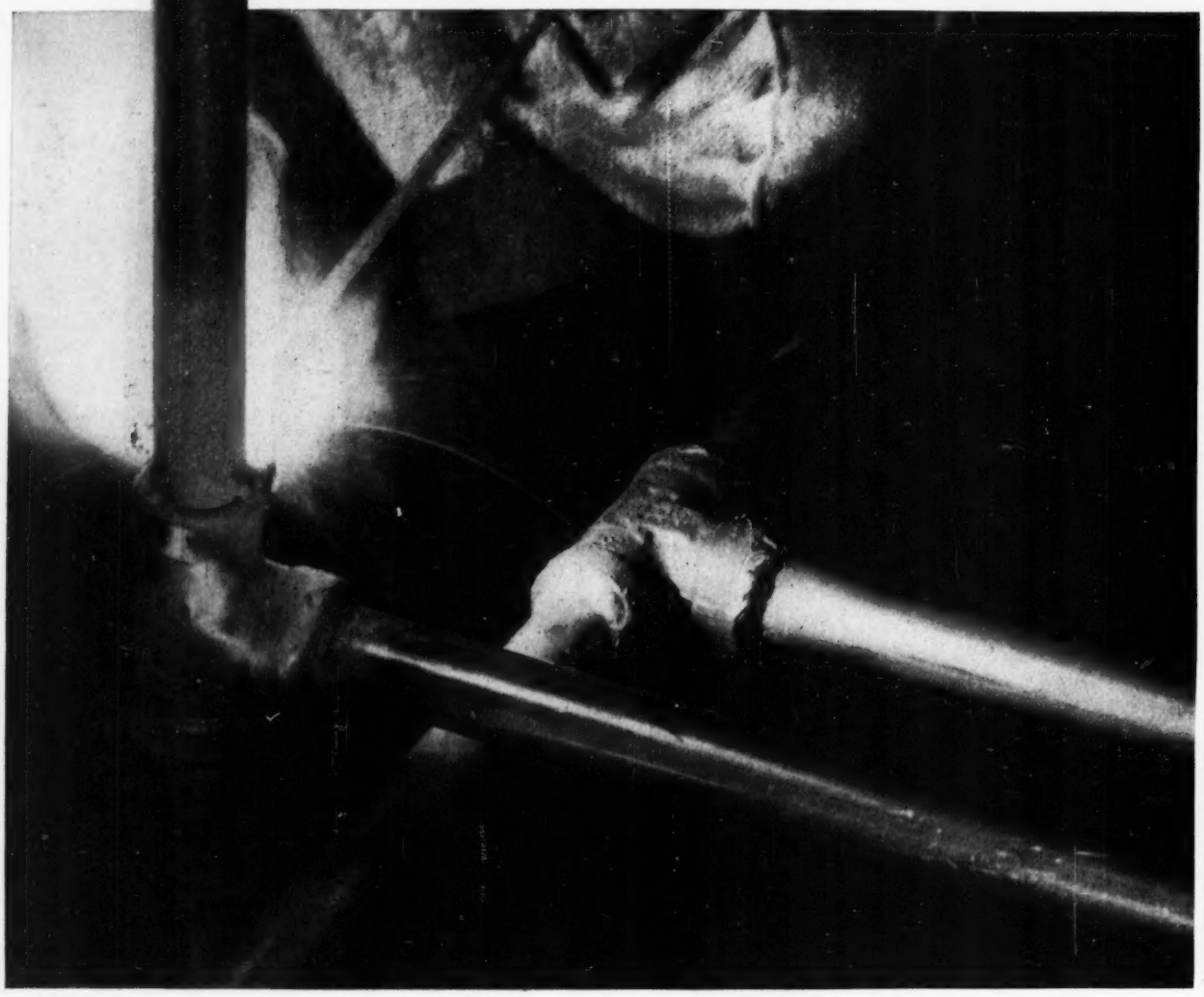

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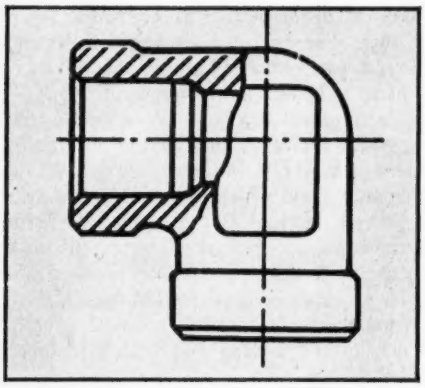
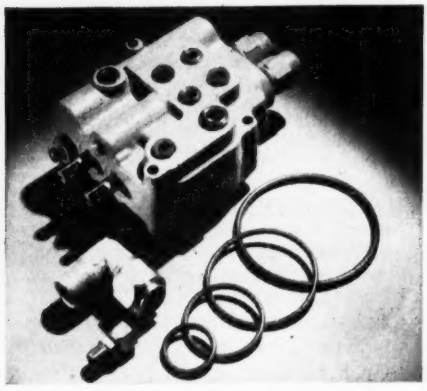
Cambridge 39, Mass.	Whitehead Metal Products Co. 281 Albany St.
Cedar Rapids, Ia.	Globe Machinery & Supply Co. 309 8th Ave. S. E.
Charleston, W. Va.	Persingers, Inc. 514 Elizabeth St.
Charlotte 1, N. C.	Industrial Piping Supply Co. 1501 Dowd Rd.
Chicago 14, Ill.	Wallace Tube Co. 1300 Diversey Parkway
Cincinnati 25, Ohio	Williams & Co. 3231 Fredonia Ave.
Cleveland 14, Ohio	B. W. Rogers Co. 1279 East 12th
Cleveland 14, Ohio	Williams & Co. 3700 Perkins Ave.
Columbus 8, Ohio	Williams & Co. 851 Williams Ave.
Dallas 9, Tex.	Metal Goods Corp. 6211 Cedar Springs Rd.
Davenport, Ia.	Globe Machinery & Supply Co. 410 E. Second St.
Dayton 10, Ohio	J. N. Fauver Co. 1534 Keystone Ave.
Denver 2, Colo.	Metal Goods Corp. 2425 Walnut St.
Des Moines 6, Ia.	Globe Machinery & Supply Co. East First & Court Ave.
Detroit 1, Mich.	J. N. Fauver Co. 49 West Hancock St.
Harrison, N. J.	Whitehead Metal Products Co. 1000 South Fourth Ave.
Houston 3, Tex.	Metal Goods Corp. 711 Milby St.
Houston 1, Tex.	Standard Brass & Mfg. Co. 2018 Franklin St.
Indianapolis, Ind.	Avels Sales & Engineering Co. 16 W. 22nd St.
Jacksonville, Fla.	Florida Metals, Inc. 2937 Strickland St.
Kansas City 18, Mo.	Metal Goods Corp. 1300 Burlington Ave.
Knoxville 6, Tenn.	Leinart Engineering Co. 412 E. 5th Ave.

Weld-lok tube fittings

. . . machined from high-quality bar stock and forgings . . . for tubing ¼ through 2 inches O.D.



Cutaway view shows details of the simple *Weld-lok* design which makes *Weld-lok* fittings easy to use. They are steel or stainless steel.



What other Parker products interest you? *Triple-lok* flare tube fittings? *Ferulok* flareless fittings? Hydraulic control valves? O-rings?

Simply push the tube in the socket, then weld! That's how easy it is to install Parker's new *Weld-lok* fittings for tubing. They're designed for applications involving extreme temperatures, corrosion conditions, or wherever permanently welded tubing joints are needed.

Weld-lok fittings have a tapered socket that aligns and holds the tube while you weld. You don't need special gripping fixtures. During welding, extraneous material can't enter the flow passage to form an obstruction. The carefully designed wall section of the fitting induces just the right amount of heat penetration for a correctly proportioned weld.

When you use Parker *Weld-lok* fittings, you get a sturdy, permanently tight line . . . unaffected by vibration, shock, or thermal distortion. Also, the inside diameter of the fittings closely matches the inside diameter of tubing to provide free flow passage.

All commonly used connectors and body shapes are now offered for tubing sizes of ¼ through 2 inches outside diameters . . . steel or stainless steel.

Ask your Parker distributor for *Weld-lok* Catalog No. 4370. Then, to order, simply use the complete part number designated for each fitting. It indicates size, shape and material.

TUBE AND HOSE FITTINGS DIVISION
The Parker Appliance Company
Section 406, 17325 Euclid Avenue, Cleveland 12, Ohio

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Los Angeles 12, Cal.	Metropolitan Supply Co. 353 E. 2nd St.
Louisville 3, Ky.	Williams & Co. 1109 S. Preston St.
Memphis, Tenn.	J. E. Dilworth Co. 730 South Third St.
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Milwaukee 3, Wis.	Morman Belting & Supply Co. 522 W. State St.
Milwaukee 4, Wis.	Wallace Companies of Wisconsin, Inc. 838 South 6th St.
Minneapolis 15, Minn.	Vincent Brass & Copper Co. 124 Twelfth Ave. South
New Orleans 12, La.	Metal Goods Corp. 432 Julia St.
Newport News, Va.	Noland Company 27th St. & Virginia Ave.
New York, N. Y.	Nielsen Hydraulic Equipment, Inc. 5 Penn Place, Pelham Manor 65
New York 14, N. Y.	Whitehead Metal Products Co. 303 W. 10th St.
Odessa, Tex.	Snyder Co., Inc. 2604 Kermit Highway
Philadelphia, Pa.	Louis H. Hein Co. 15 W. Lancaster Ave., Ardmore
Philadelphia 40, Pa.	Whitehead Metal Products Co. 1955 Hunting Park Ave.
Pittsburgh 33, Pa.	Williams & Co. 901 Pennsylvania Ave.
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Rockford, Ill.	Rockford Tool & Transmission Co. 802 Broadway
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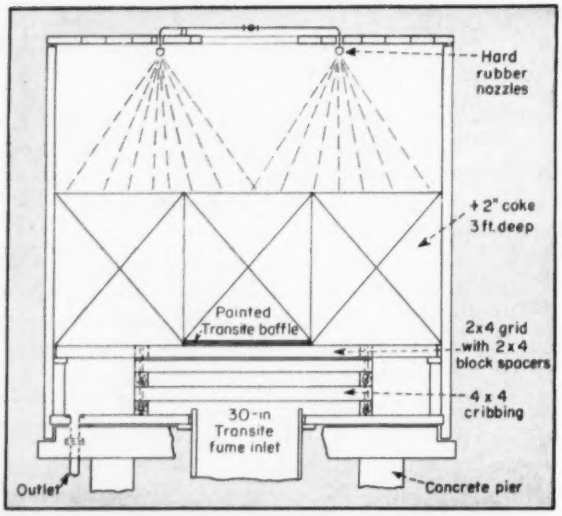
San Francisco 3, Cal.	General Machinery & Supply Co. 1346 Folsom St.
Seattle 9, Wash.	Palmer Supply Co. 222 Westlake North
Shreveport, La.	Standard Brass & Mfg. Co. 1557 Texas Ave.
St. Louis 15, Mo.	Metal Goods Corp. 5239 Brown Ave.
Syracuse 4, N. Y.	Whitehead Metal Products Co. 207 W. Taylor St.
Tampa, Fla.	Florida Metals, Inc. 222 N. 12th St.
Toledo 2, Ohio	Williams & Co. 650 E. Woodruff Ave.
Tulsa, Okla.	Ardun Supply Co. 303 S. Frankfort
Tulsa 3, Okla.	Metal Goods Corp. 302 N. Boston
Canada	Railway & Power Engineering Corp., Ltd.
Export	Mercator Corp. 438 Walnut St., Reading, Pa., U.S.A. Korody Marine Corp. 12822 Simms Ave., Hawthorne, California, U.S.A.

The Plant Notebook

Edited by Theodore R. Olive



Surplus Wood Stave Tank Converted to Efficient Acid Fume Scrubber

J. E. Weiler, *Process Engineer, Niagara Falls, N. Y.*

★ March Contest Prize Winner

A process which produced a relatively low annual dollar volume of product was giving off 5,000-7,000 cfm. of dilute HCl fume. It was clear that the process could not justify an elaborate fume scrubber, but equally clear that the discharge of acid fume to the air could not be continued in the future.

We met the problem successfully with an out-of-pocket expenditure of only about $700 by using a surplus 9 x 9-ft. wood stave tank as a wet scrubber. The cost figure included lumber, packing, piping to the scrubber, piers for its support, and erection labor. It did not include the value of the surplus tank. Nor did it include the cost of the existing fan and duct system which collected the fume from the process. The sketch indicates the construction of the scrubber. The tank was set on concrete piers about 3½ ft. above ground level. A 32-in. dia. hole was cut in the center of the bottom to receive the 30-in. Transite fume duct. The duct projects a few inches above the bottom to prevent back-flow of scrubber liquid, and is sealed in place with duct joint compound.

Packing is supported as follows: A cribbing of fir 4 x 4's supports a grid of fir 2 x 4's, both held in position by wood dowels. The packing is a 3-ft. deep bed of 2-in. domestic coke resting on the grid. Water for scrubbing is distributed over the packing by four 60-deg. solid-cone hard-rubber spray nozzles connected by hard-rubber supply piping supported on the cover of the tank. The Transite fume duct is coated on all exposed surfaces with acid-resisting paint. A painted flat sheet of Transite positioned directly above the inlet duct on the packing grid deflects scrubber liquid away from the fume inlet.

In operation there is a very faint HCl odor at the vapor discharge. Scrubbing could be made somewhat more efficient by increasing the packing depth, water flow and fan power, but this is not needed. The fan used is rated at 7,500 cfm., 5 hp., 3 in. H_2O static pressure. Pressure drop of the scrubber is 2½ in. H_2O. The liquid discharges at 15 gpm., containing 0.6 percent HCl, which is equivalent to 45 lb. HCl per hr., or 1,270 ppm. based on the weight of air handled.

Algebraic Trick Facilitates Computation

D. S. Davis, *Professor of Chemical Engineering, Virginia Polytechnic Institute, Blacksburg, Va.*

Computation by means of the usual 10-in. slide rule can often be improved in convenience and accuracy through rearrangement of an equation or through substitution of an auxiliary variable. As an instance of gain in facility through rearrangement, consider the familiar device of re-

---

★ April Contest Prize Winner

"Magnetically Operated Flow Splitter for Reflux-Product Split in Stills."

A prize of $50 in cash will be awarded to J. J. Kauklis, Chemical Engineer, The Barrett Division, Frankford, Philadelphia, Pa. Mr. Kauklis' article will appear in the Plant Notebook section for July.

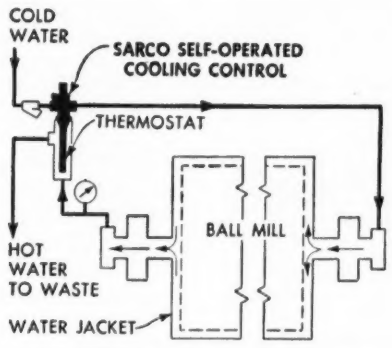
$50 PRIZE FOR A GOOD IDEA—Until further notice the Editors of *Chemical Engineering* will award $50 cash each month to the author of the best short article received that month and accepted for publication in the Plant Notebook. Each month's winner will be announced the second following month and published the third following month.

$100 ANNUAL PRIZE—At the end of each year the monthly winners will be rejudged to determine the year's best Plant Notebook article, which will then be awarded an additional $100 prize.

HOW TO ENTER CONTEST—Any reader of *Chemical Engineering*, other than a McGraw-Hill employee, may submit as many entries for this contest as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Articles which are acceptable but are not winners will be published at regular space rates ($10 minimum).

Articles may deal with plant or production "kinks," or novel means of presenting useful data, which will interest chemical engineers. Address plant Notebook Editor, *Chemical Engineering*, 330 West 42nd St., New York 36, N. Y.

How to get more out of process steam



Sarco Cooling Control hook-up on ball mills at Berry Bros. Inc.

Why it Pays to Control Water Jacket Temperature

Sometimes a process calls for cooling rather than heating. Take this typical case history.

Berry Brothers Inc., paint manufacturer in Detroit, uses ball mills to grind pigments. Using manual control, operators were unable to hold jacket water at required temperatures. Since jacket temperature affects grinding time, a costly bottleneck was created in the mill department. Grinding time varied from batch to batch.

Sarco suggested the installation of one of its *self-operated* temperature regulators based on the hook-up shown above.

Results: Cooling water is now maintained at required temperatures. Operations are faster and on a time-table basis. Installation was so successful, Sarco Cooling Controls are now installed on 19 ball mills. Meter tests made by the plant superintendent show monthly savings of $40 to $45 in reduced water consumption.

Sarco self-operated T-44 Cooling Control, automatically holds water at control point by close throttling of discharge flow. Ask for bulletin.

. . . to improve product quality, reduce production costs, eliminate bottlenecks

Make sure the steam traps and temperature controls on your process equipment have been properly specified and installed.

Here's why! Very often when production schedules are upset and steam costs seem relatively high, you'll find the trouble is not with the process equipment . . . *but with the way steam is used!*

Avoid These Production Headaches

The wrong type of trap can cause waterlogging and keep equipment from reaching and maintaining proper temperatures. Result: production slow-downs and waste of steam. Air film caused by inadequate venting drastically reduces heat transfer and prolongs processing time. Erratic temperature control is often the cause of rejects or product spoilage and further raises production costs.

Call In Sarco

Plant after plant has benefited from Sarco's experience in the process industries. Backed by a complete line of steam traps and temperature controls, Sarco engineers are able to offer you impartial, expert recommendations on how to *get more out of process steam.*

For case histories describing how other plants in your field solved similar problems, write today to Sarco Company, Inc., Empire State Bldg., New York 1, N. Y.

SARCO

improves product quality and output

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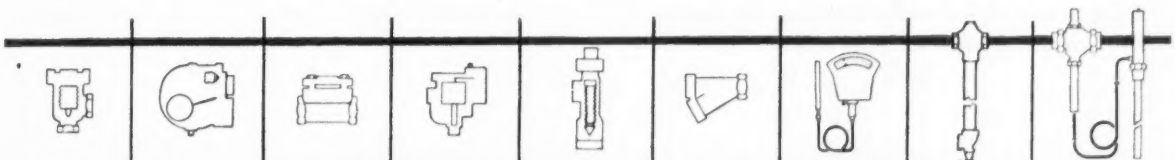
STEAM TRAPS • TEMPERATURE CONTROLLERS • STRAINERS



Thermostatic Steam Traps | Float-Thermostatic Steam Traps | Thermodynamic Steam Traps | Camlift Bucket Steam Traps | Liquid Expansion Steam Traps | Strainers | Electric Temperature Controllers | Water Blenders | Self-Operated Temperature Controllers

placing the integrated Clausius-Clapeyron equation

$$\ln \frac{p_2}{p_1} = -\frac{\Delta H}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right) \quad (1)$$

with

$$\ln \frac{p_2}{p_1} = -\frac{\Delta H(T_1 - T_2)}{RT_1T_2} \quad (2)$$

when computing ΔH from known values of pressure and temperature. Eq. (1), which involves the difference of two reciprocal temperatures that are always nearly equal, cannot be used to determine ΔH by means of a 10-in. slide rule with the convenience and accuracy that attend the use of the mathematically equivalent Eq. (2).

As an instance of the gain in facility through substitution of an auxiliary variable, consider computation of the boiling point (at 760 mm.) of allyl alcohol from the vapor pressure (708.7 mm.) at 95.0° C. (368° K.) and the latent heat of vaporization, 9,950 Btu. per gram-mole. Substitution of these data in Eq. (2), where $R = 1.985$ cal./(gram-mole, deg. K.), yields:

$$2.303 \log \frac{760}{708.7} = -\frac{9{,}950(368 - T_2)}{1.985(368)T_2} \quad (3)$$

Now if we let $\Delta T = T_2 - 368$, then $T_2 = 368 + \Delta T$. Substituting in Eq. (3) results in

$$2.303 \log \frac{760}{708.7} = \frac{9{,}950\Delta T}{1.985(368)(368 + \Delta T)}$$

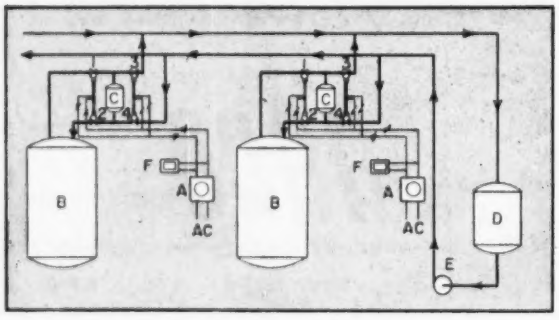
or

$$0.00001397 = \frac{\Delta T}{368 + \Delta T}$$

and

$$\Delta T = 1.9$$

From this $T_2 = 368 + 1.9 = 369.9°$ K. or 96.9° C. But if we determined T_2 from Eq. (3) without the use of the auxiliary variable ΔT, then a late stage would give $0.9948\ T_2 = 368$. But, a 10-in. slide rule would yield from this only the approximate value of 370° K. or 97° C.



Automatic Metering System Charges Liquid to Bank of Reactors

J. E. Smith and W. R. Ludka, *Chemical Engineering Dept., Minnesota Mining & Mfg. Co., St. Paul 6, Minn.*

In metering the same liquid raw material to a bank of process vessels in a multi-unit plant, the usual devices are sometimes unsatisfactory. If the amount of material being charged is small, flow meters lose their accuracy or require constant adjustment. If extreme accuracy is required, the only way of knowing exactly what is being charged to each vessel is to employ duplicate weigh tanks with flow meters or feed pumps for each vessel. Such a duplication of equipment is quite expensive both in original cost and in maintenance, especially if the material being metered is very corrosive.

The system shown in the sketch was developed to overcome the shortcomings of the usual metering devices in such an application. It has proven to be very accurate, completely automatic, and considerably less expensive than duplicate weigh tanks with metering pumps for each vessel. It requires very little attention or maintenance and can be constructed to handle the most corrosive liquid.

The equipment is described as follows:

1. Timers *A* are variable-cycle, variable-total-period units, such as the Eagle Flexopulse or ATC Duo-Set.

2. Vessels *C* are fixed-volume charge tanks. Their size depends on the amount of material to be charged to the process vessels.

3. Vessels *B* are the process vessels to which the metered material is to be added. It may be under any pressure.

4. Vessel *D* is the storage tank for the metered liquid.

5. Pump *E* is any type chemical pump which will pump the metered material. It may be a low-head centrifugal. Its capacity should be twice the total amount of material needed per unit of time.

6. Valves 1 and 2 are "normally open" solenoids.

7. Valves 3 and 4 are "normally closed" solenoids.

8. Counter *F* may be any suitable totalizer operating on an electrical impulse.

Parts *A*, *C*, F, 1, 2, 3 and 4 are duplicated for each reactor in the bank, and operate independently. A sequence of operation for one assembly of this equipment is as follows:

1. As timer A moves to the "on" position, it energizes the four solenoid valves and trips Totalizer F. Valves 3 and 4 open and Valves 1 and 2 close.

2. The metered liquid is pumped through Valve 4 into Charge Tank *C*, overfilling it and flowing back to Storage Tank *D* through Valve 3 and the return line.

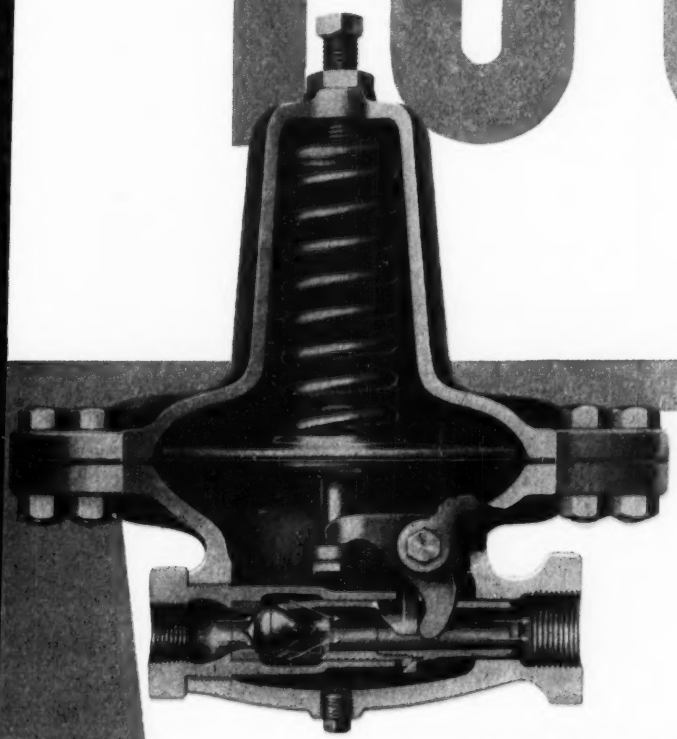
3. This phase continues for approximately one-half of the total period. Then, as Timer A moves to the "off" position, it de-energizes the solenoids. Valves 3 and 4 close, and 1 and 2 open.

4. A fixed volume of liquid drains by gravity from Charge Tank *C* to Reactor *B* through Valve 2. The pressure between Charge Tank *C* and Reactor *B* is equalized through Valve 1.

5. This phase continues for about one-half of the total period. Then, Timer A moves to the "on" position and the cycle is repeated.

To adjust the rate of charging to any reactor, the total period is changed on the timer. Assume the charge tank has a capacity of 1 qt.. If 4 qt. of material is needed each hour, the total "on-off" period is set for 15 min. If 2 qt. is needed each hour, then the total timer period is set for 30 min.

TYPE 1000 VALVE



Any product of quality should be dependable when *ordinary* products fail. Sudden pressure fluctuations, dirt, scale and viscous matter prove "fatal" to ordinary pressure reducing valves.

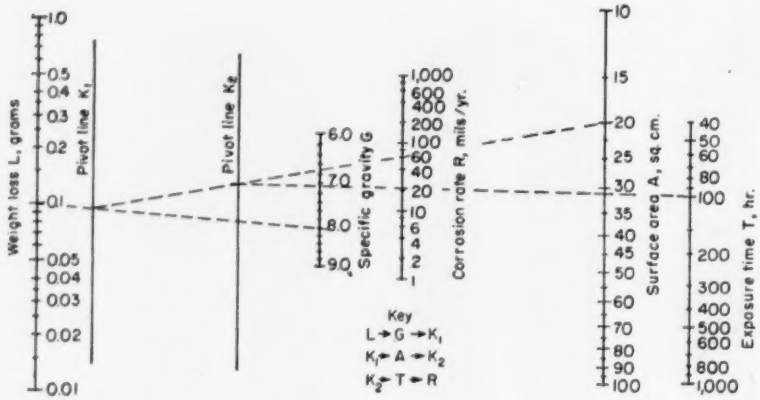
The CASH STANDARD TYPE 1000 VALVE however, is designed to operate with complete dependability under the most difficult and unusual circumstances. Many of these units have been in service over 10 years and have never been taken "out of the line."

Truly an *EXTRAORDINARY* achievement of quality and design excellence.

INSTALL CASH STANDARD "TYPE 1000" VALVES

CASH STANDARD **DECATUR, ILLINOIS**

A. W. CASH COMPANY



Nomograph Finds Corrosion Rate

HAROLD R. FRISBIE, *Walnut Creek, Calif.*

In selecting materials of construction for new process equipment, one must often determine anticipated rates of corrosion. This is usually done by suspending a disk of the same material as the proposed equipment in contact with the liquids or vapors, and under the same conditions of temperature and pressure as would be encountered in the process. The weight loss of the disk is measured after exposure for a known length of time and the corrosion rate determined from the equation:

$$R = 3.449 \times 10^6 (L/GAT)$$

where R = rate of corrosion in mils per year; L = weight loss of the test sample in grams; G = specific gravity of the test sample; A = surface area of the test sample in sq. cm.; and T = time the sample is exposed, in hours.

The nomograph presented here offers a simplification of this calculation. The use of the nomograph is illustrated as follows: A test sample having 20 sq. cm. of surface area (A) and a specific gravity of 8.0 (G) lost 0.1 grams (L) after 100 hr. (T) exposure to a solution. On the nomograph draw a line from 0.1 on the L scale to 8.0 on the G scale. From the intersection of the line with the pivot line K_1 draw a line through 20 on the A scale to establish the pivot point on the K_2 line. The line drawn from this point through 100 hr. on the T scale intersects the R scale at 21.5 mils per yr., the rate of corrosion under the conditions selected. The chart is well within the limits of accuracy of the test involved.

Nomograph Speeds up Orifice Meter Computations for Gas Flow

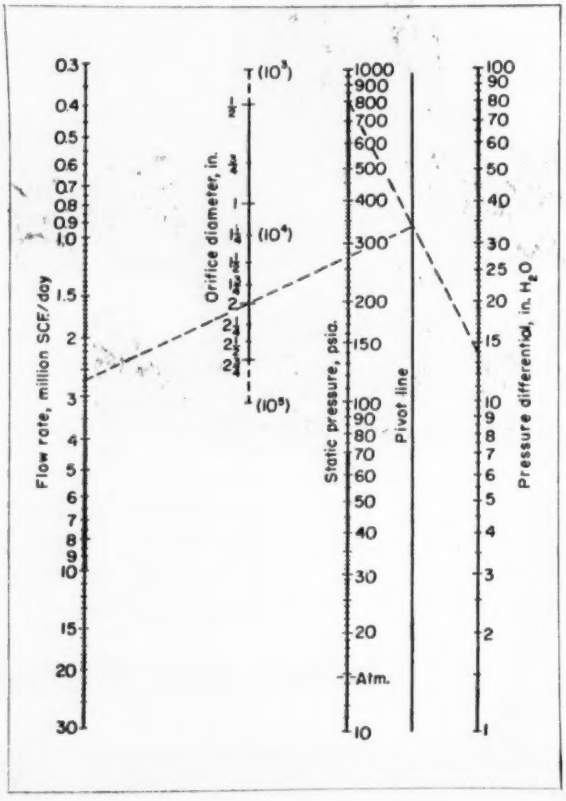
C. J. CARMICHAEL, JR., *Chemical Engineer, Gas-Gasoline Dept., Production Div., Gulf Oil Corp., Houston, Texas.*

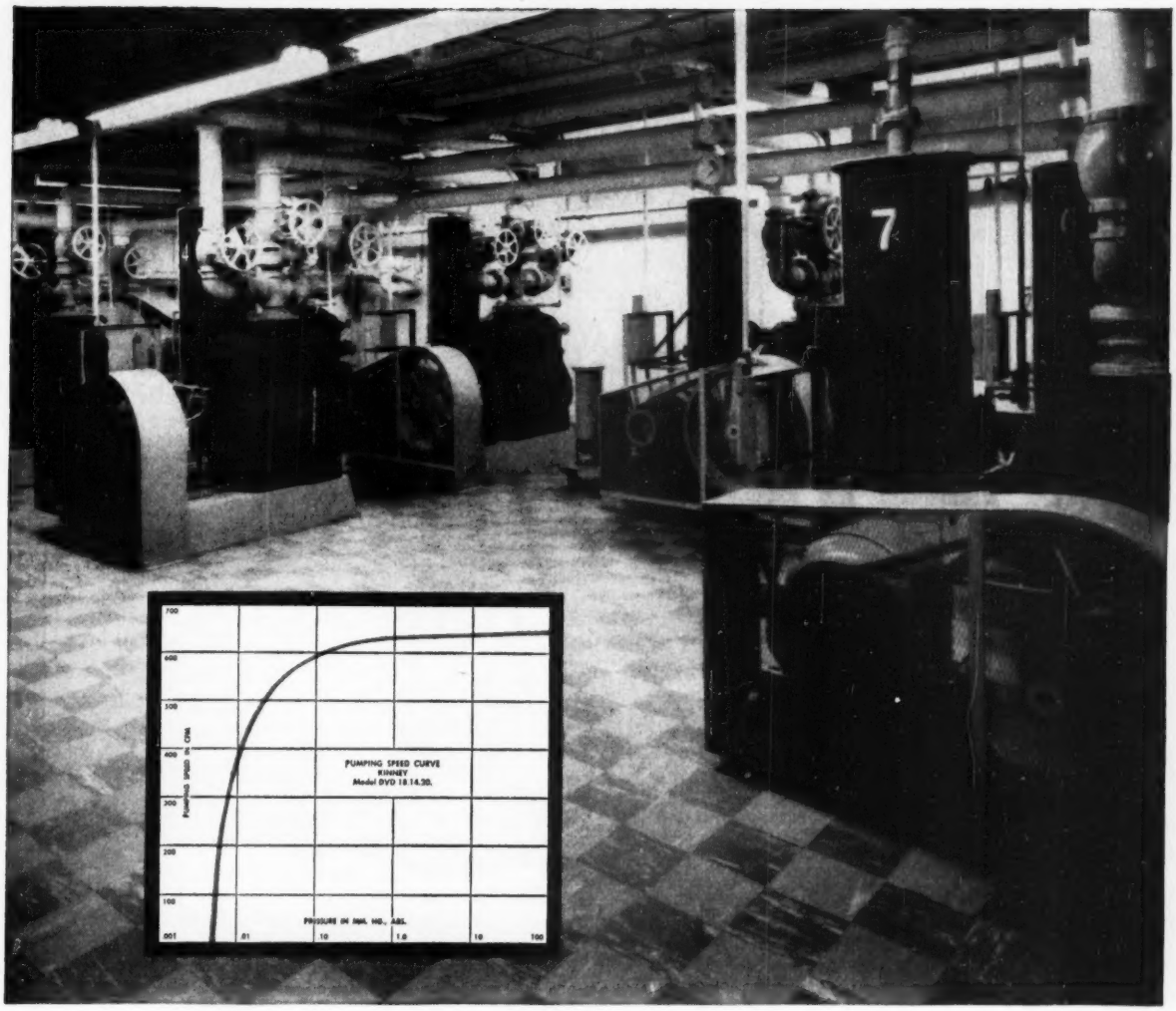
The nomograph presented here not only saves time in the computation of gas flow rates measured by orifice meters: it also has the further advantage of enabling non-technical personnel to calculate gas flow rates.

As originally drawn up with 5 in. scales (such as the scales of two-cycle logarithmic paper of conventional notebook size) the chart has an accuracy comparable to that of a 5-in. slide rule. As with any log scale the percentage accuracy of readings will be independent of the position.

This particular nomograph, which was drawn only for illustrative purposes, uses orifice coefficients common to natural gas. Any coefficient could be computed and used. The coefficient scale is one-half that of the static, differential and flow rate scales. The chart is computed for flow through a 4-in. line, as measured by orifice plates from ¼ to 2¾ in. in diameter, equipped with flange taps. It is based on 0.60 gravity gas, with a 14.65 psia. pressure base and a 60 deg. F. flowing temperature.

The example shown is for a static pressure of 785 psig., with the flow producing a differential of 14 in. H_2O through a 2.0-in. dia. orifice. The flow rate is found to be 2.72 million SCF./day, based on 0.60 specific gravity natural gas. Corrections (usually minor for plant work) could be applied for flowing temperature, compressibility factor, specific gravity, etc.





They use Fast Vacuum

In the lamp and tube manufacturing business, you will find many "house vacuum" systems like this . . . built around super-dependable Kinney High Vacuum Pumps. This particular room, in the plant of a leading manufacturer of electronic and electrical equipment, contains seven Kinney Model DVD 18.14.20 Pumps with a combined vacuum potential of 5,000 cubic feet per minute. This is the heart of the vacuum exhausting process . . . the key to fast pump-down and fast production.

Whatever your vacuum problem — whether it's a laboratory job requiring a 2 CFM pump or a full scale production problem like this — there's a Kinney Pump to fit your needs. Kinney district offices are staffed with competent vacuum engineers, ready to help you get the right vacuum pump for each application.

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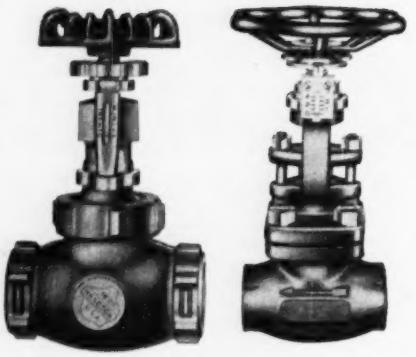
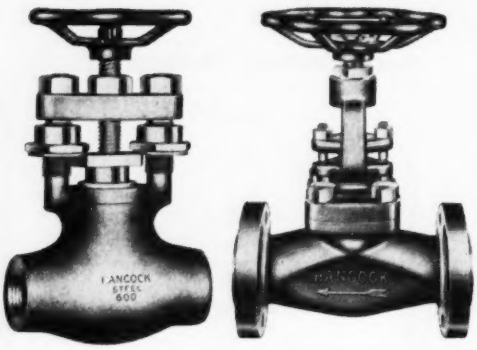
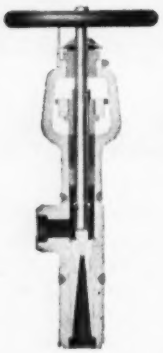


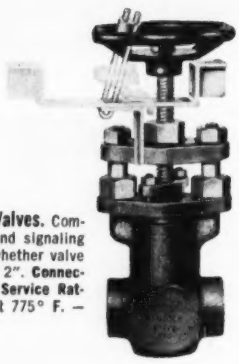
"Flocontrol" Valves. 3-in-1 design combines variable orifice, shut-off and index. BRONZE: **Types:** Globe and Angle. **Sizes:** ¼" through 2". **Connections:** Screwed Ends. Available in 150# and 300# series. STEEL: **Types:** Globe and Angle. **Bolted Bonnet and No Bonnet Joint Designs.** Sizes: ¼" through 4". **Connections:** Screwed, Socket Weld and Flanged Ends. Available with 150#, 300# and 600# series flanges.

600# Steel Valves. Dependable, trouble-free in the severest services. **Sizes: No Bonnet Joint Design** (left below) — ¼" through 2". **Bolted Bonnet Design** (right below) — 1¼" through 2". **Types:** Globe and Angle. **Connections:** Screwed, Socket Weld and Flanged Ends. **Service Ratings:** For **all** pressures up to 850 psi at 750° F. — O.W.G. 2000#, 100° F.





600# through 2500# Hi-Pressure Drop Valves. For continuous blowdown service. Combine orifice, shut-off and index in a single unit. **No Bonnet Joint Design.** Sizes: ¾", 1" and 1½". **Orifice Sizes:** ⅛" minimum; 1" maximum. **Connections:** Screwed or Socket Weld Ends.



Water Column Shut-Off Steel Gate Valves. Combine a single, positive-acting locking and signaling device. Red flag indicates at a glance whether valve is open or closed. **Sizes:** 1¼" through 2". **Connections:** Screwed and Socket Weld Ends. **Service Ratings:** For **all** pressures up to 800 psi at 775° F. — O.W.G. 2000#, 100° F.

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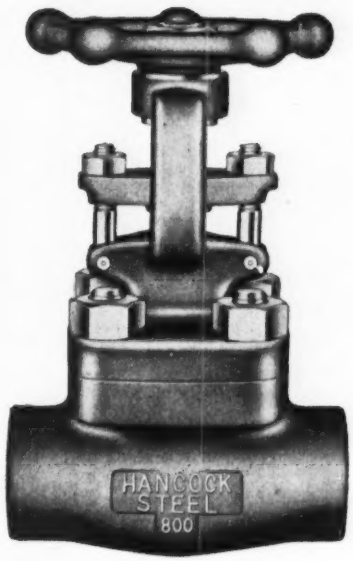
The operational perfection and extra service life engineered into all Hancock Valves are yours at the cost of ordinary valves. Whether you are adding new capacity to present facilities, planning a new plant or a revalve project, learn all the money-saving reasons why Hancock Valves belong in your specifications. Complete information is yours on request.



800# Steel Gate Valves. More than meet the requirements of process piping systems. **Bolted Bonnet Design. Sizes:** ¼" through 2". Type 950 illustrated offers these alternate trims: (a) Cobalt-Chromium-Tungsten Alloy, Hard Facing—"420 Brinell"; (b) 18-8% Stainless or 20% Nickel, 8% Chrome; (c) Monel; (d) Hastelloy. **Connections:** Flanged Ends — for **all** pressures up to 800 psi at 775° F. — O.W.G. 1440 psi, 100° F. Screwed and Socket Weld Ends — for **all** pressures up to 800 psi at 775° F. — O.W.G. 2000 psi, 100° F. **No Bonnet Joint Design. Sizes:** ¼" through 2". **Connections:** Screwed and Socket Weld Ends — for **all** pressures up to 800 psi at 775° F. — O.W.G. 2000 psi, 100° F.

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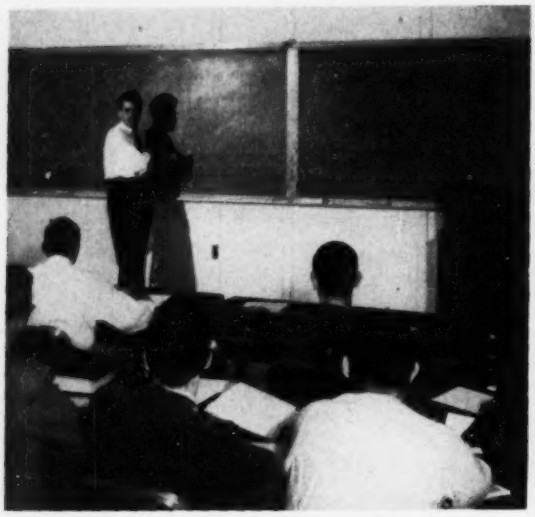


CLASSROOM LECTURES serve to supplement the . . .

HOMEWORK PROBLEMS, as GE aids young engineers in . . .

Getting Off on the Right Foot

A top-notch training program helps you attract young engineers and get their best work from them. Here's how GE's program, one of the biggest, operates.

In step with the times, the General Electric Co. maintains a vast network of employee training and educational programs—one of the biggest to be found anywhere. GE executives admit that it takes a tremendous investment in time, money and materials to keep the system running, but you'd have a rough time of convincing them that it isn't worth it.

Why does it bother with such an extensive—and expensive—training program?

In the first place, the folks at General Electric have found that it is virtually impossible to place the young engineer, fresh out of college, into a permanent position—best for both him and the company—on the first crack. And it stands to reason that if a man doesn't get into the spot for which he is best fitted as soon as possible he loses and the company loses—sometimes considerably.

What the Program Attempts

It is to find out more about the young engineer and to help him discover where he can make his greatest contribution, as well as to make sure that he has the proper tools with which to exert the greatest effort, that GE maintains its vast system of education.

The GE programs strive to fill 3 chinks in the young engineer's professional armor:

- Experience in the various phases of his engineering specialty.
- Knowledge of his field that is both comprehensive and up to the minute.
- Ability to bring this experience and knowledge to bear in the solving of engineering problems.

Why Chemical Engineers?

General Electric—the name notwithstanding—is a fair-sized chemical company, and, since it feels that many of the future advances in the electrical industry will be the result of improved materials and processes, chemical engineers come in for special attention in its training set-up. In fact, it has incorporated a program aimed straight at the ChE into its slate of engineering courses.

To learn the whys and wherefores of this program let's follow a typical trainee as he moves through his first two years with General Electric.

Training Program an Inducement

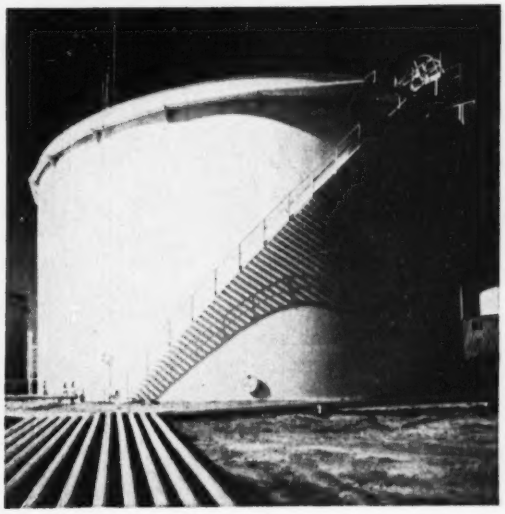
Actually, it was the extensive educational set-up that "sold" Paul Stokes on GE in the first place.

NEXT MONTH . . .

Writing chores got you down? Well, help is on the way as a professor and a professional—the head of Rensselaer's Technical Writing Institute and the editor of the SAE Journal—team up to chase your woes. Look for it in next month's YOU AND YOUR JOB.

MINALS

D THAT CAN BE TRANSPORTED



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Questions and answers after class.

Interviews biweekly with class supervisor.

The college recruiter had described the Chemical and Metallurgical (Chemet) Program, in which he would receive a series of four 3-mo. job assignments in different types of work at various plant locations—the better to discover the type of work to which he was best fitted.

He also described the Advanced Technical Course and the Process Technology Program in which Paul could receive further, intensive training in chemical engineering—if he desired such training and could meet the requirements for selection.

Even before the interviewer got around to pointing out the myriad other courses and lecture series that would be open to him, Paul had his mind pretty well made up.

Learning on the Job

His first assignment with GE was in a process development group in the Cincinnati plant. Paul was surprised to find that he was immediately assigned a responsible job. He had figured that while on the program his jobs would be more or less routine. But General Electric, long espoused of the "learn by doing" philosophy, feels that only by working at responsible jobs and helping solve the problems actually encountered can the trainee gain from the program.

It was while at Cincinnati that Paul applied for the Advanced Technical Course. Right off the bat he was given a searching personal interview which, in conjunction with supervisors' reports and several tests, made an evaluation of his character, personality, initiative and aptitude for further training.

The Technical Education staff member who conducted the interview was looking principally for an insight into Paul's interest and ambitions and for a measure of his technical ability and its limitations. He found that Paul had just about the right mixture of enthusiasm and ability that he was on the lookout for.

Program Given of Major Plants

The Advanced Technical Course is designed to run concurrently with the Chemet Program and, since it is offered each year in all the major plant locations of the company on a synchronized schedule, it really didn't matter where the next of Paul's rotating assignments took him.

But along about the beginning of September he received instructions to report to the Plastics Division's Pittsfield, Mass., plant for production work—his next rotation assignment.

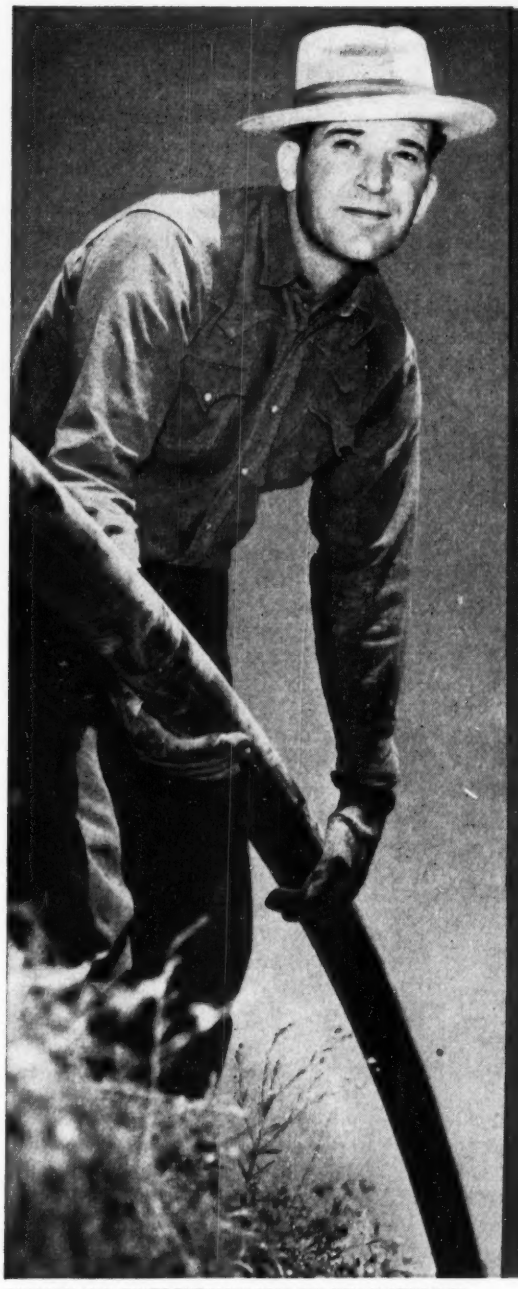
He arrived at Pittsfield on a Monday morning and found that—as at Cincinnati—machinery had already been set up to help him arrange for living quarters. Paul lost no time in getting settled and reporting for work.

The job at Pittsfield took Paul out into the plant and introduced him to such phases as production schedules, maintenance and safety inspections, supervision of operators and the like. He found plenty to keep him busy and plenty to learn. And he was introduced to the pragmatic philosophy of the plant engineer—if it works, it's good; if it doesn't work, it's no good no matter who says so.

Soon after Paul started working in production, classes for the Advanced Technical Course were formed. Once each week for a period of four hours (during regular working hours) his class met for lectures and discussions. Lectures, Paul found, were given by men in the company considered to be experts in the field being studied. This gave Paul the opportunity to learn of the latest developments and techniques in that field.

Problems Are the Basis

But it didn't take him long to learn that the problems were the guts of the course. Quite often these came directly from one or another of the operating divisions of the company. All, however, were chosen because they required the application of the various funda-



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Tetrapropylene
Tripropylene
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Benzene
Acetone
Methyl Ethyl Ketone

Try Your Hand at This Typical Problem

In General Electric's training programs the problems constitute the guts of the course. Generally, they come directly from one of the operating departments and go to the students "unvarnished"—with no simplifications or "helps." Sometimes there are no answers, sometimes there are many, invariably they are difficult to arrive at. Here's one that the students struggled with for some 15 to 20 hours. How would you solve it?

▶ It has been proposed that hydrogen and nitrogen be separated in a device consisting of an insulated tube having both ends capped off with orifice plates. The idea is to feed the hydrogen-nitrogen mixture into the tube midway between the orifice plates, feed steam into the tube near one orifice plate and get the desired separation by allowing the more diffusable component diffuse through the steam. The orifice plate near the steam inlet pass steam and a gas, rich in the more diffusible component (hydrogen).

• Develop a relationship or method of calculation for determining—as a function of the system variables—the quantity and purity of hydrogen that can be obtained.

• Devise a system for obtaining 90 mole percent hydrogen from a feed containing 50 mole percent hydrogen.

• Does the system look feasible?

mental concepts and techniques learned in college and amplified in the lectures.

Each problem assignment required about 15 to 20 hours of outside work—topped off by a short engineering report written to present both the results and the method of investigation.

The problems were then discussed in class with either a class member or one of the engineers who first encountered the problem in the course of his day-to-day work leading the discussion. It was this part of the course which Paul enjoyed most. In the give and take of class discussion he learned some of his most valuable lessons.

Biweekly Chats a Help

But that wasn't all. Every two weeks Paul had the chance to spend an hour and a half with his class supervisor, chatting about the homework and his approach to solving the problem, working out personal problems and discussing course options.

Paul didn't know it at the time but his class supervisor put a lot of thought into preparing for these interviews. His job is not only to advise and counsel Paul but to constantly evaluate his performance. The class supervisor is also charged with keeping Paul up-to-date on his standing and his progress—both in the course and on the job.

Learning How to Solve Problems

The Advanced Technical Course was designed primarily to help Paul and the others learn how to solve problems. It taught him how to recognize and define a problem, how to select a method of solution, how to work it through and how to evaluate his answer.

Constantly working on actual situations—not textbook fabrications—helped him acquire a certain adeptness in the various facets of problem solving as well as greater facility with the instruments of problem solving — mathematics, writing, sketching and the ability to call on and use general knowledge.

GE, he learned, feels that this is one of the most important parts of its entire educational system. The man who knows how to meet and master problems—any problems—can't miss being valuable to them.

Gaining More Technical Knowledge

After receiving another of his 3-mo. job assignments—this time to GE's General Engineering Laboratory in Schenectady, N. Y., to work on the development of new process instruments—Paul applied to and was accepted for another training program, the Process Technology Program.

Whereas ATC had concentrated on teaching him the techniques of problem solving, in PTP Paul was to learn the up-to-the-minute technology of the many phases of chemical engineering. Emphasis in this course is placed on the approach to solving practical industrial problems of a highly technical nature.

The program is open to all engineers in the company who have completed the first semester of ATC. Generally, however, the applicants are chemists, chemical engineers and metallurgists.

What They Are Taught

Immediately following the first semester of ATC, Paul and the other men selected for the Process Technology program were given a common semester during which they studied heat transfer, thermodynamics and statistics. Paul noticed that every effort was made to integrate the various subjects which he had studied in college and to point out the fundamental laws common to many of them.

The final year of the year-and-a-half course offers two separate options—one for the metallurgists and one for the chemists and chemical engineers, the process option. Selecting the process option, Paul studied subjects ranging from the techniques of handling multicomponent distillation calculations to process cost estimation and even market research techniques.

How the Teaching Is Done

Physically, Paul found the PTP pretty much the same as the ATC. Classes were still held once a week—for four hours on one day—and the whole course still revolved

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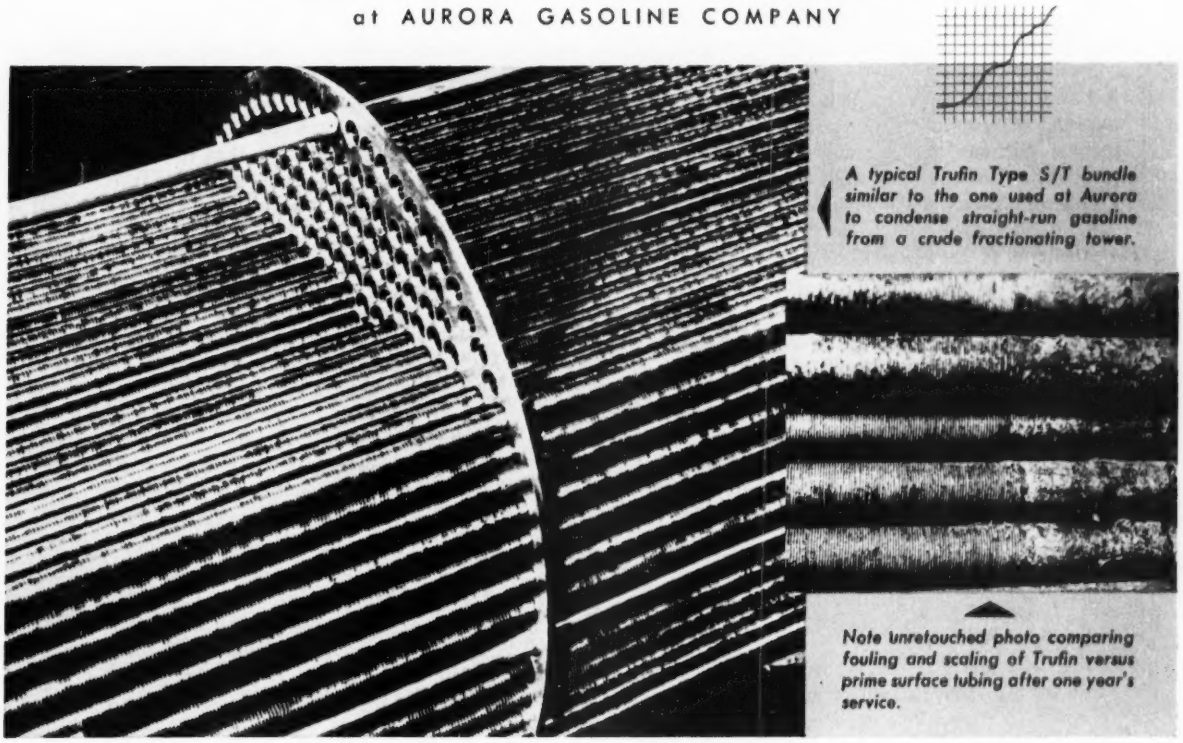

A typical Trufin Type S/T bundle similar to the one used at Aurora to condense straight-run gasoline from a crude fractionating tower.

Note unretouched photo comparing fouling and scaling of Trufin versus prime surface tubing after one year's service.

Increased production of an existing "stand-by" condenser at Aurora Gasoline Company, Detroit, Michigan called for the installation of additional condensing surface area. The stand-by unit—a small, prime-surface tube unit—was not originally designed for this kind of service.

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around the weekly problems, with class discussions and more biweekly interviews.

All of the lectures are kept as up-to-date as this month's technical magazine—which may very well wind up as one of the texts used in the course. The latest literature, both books and articles, is used as a reference source for the program.

The courses are pretty hi-powered. Lectures are usually rather concentrated dosages of the subject even though they are apt to be informal discussions. Most mathematical portions are provided in printed form to avoid any need for extensive distracting note-taking. And a question-and-answer period at the end of the class lets Paul and the others sort of gang up on the lecturer and fire queries from all angles.

Lecturers for the course are selected from all parts of the company and from all branches of engineering. This is deliberate policy. Aside from increasing the student's circle of acquaintance within the company, it helps him adjust to working with those of other disciplines. And aquaints him with other systems of nomenclature.

Pupil Rates the Teacher

Paul was pretty impressed with most of the course lecturers and reflected his impressions in his ratings of them. That's right, after every lecture the students get to rate both the speaker and the subject matter. It's another facet of GE's belief that "These fellows are mature, intelligent men—let's treat them as such."

Naturally, however, GE also desires another voice, sometimes a more objective voice, in its rating system. This is supplied by the class supervisors—a small group of course graduates who plan and sit in on all classes and who guide and counsel the students.

Constant Tie-In to Practice

Both the class supervisors and the lecturers strive unceasingly to tie the classroom work and the homework problems to the practical day-to-day work of the company.

For example; in a lecture on solution theory the instructor may derive 3 or 4 relationships between the various physical properties, then after discussing the assumptions and limitations of each he'll tell them to "be practical, use the one that fits the need and the time available." Finally, he'll give them a comparison of the results obtained with each so they'll have some idea of the error involved in their answer.

Constant emphasis on the practical has been found to pay immediate dividends. Paul and other students look for ways to tie the course work to their jobs—and vice versa. They go through fewer waste motions in solving problems, thus saving time and energy.

Important Jobs on Assignment

While in the Process Technology Program, Paul received several other job assignments. The last of his three-month assignments took him to Waterford, N. Y. to assist in the start up of new plant facilities and for a taste of process engineering. Paul's last two assignments were each 6 months long—to run concurrently with his final year on the PTP.

The first was with a market research group exploring the market potential of one of GE's new chemical products. Here Paul's technical background was useful in solving problems that were subtantially nontechnical, it was all quite new and intensely interesting to him.

Paul's final assignment took him from the marketing to the research end of the company, as he spent some six months doing basic research on combustion chambers at General Electric's famous Knolls Laboratories near Schenectady.

Does It Work?

It was at the banquet given to mark the end of the course that Paul had a chance to sound off with his feelings about the whole training system.

What did he like about it? "That's easy. The adult approach, the chance to try my own ideas, the feeling of self-confidence that I noticed growing in me as I learned to teach myself and watched myself solve some pretty rough problems and handle my end of those problem discussions. One thing I know is that I'm a much better engineer for having been on the program."

How about the company? How does it feel? "One of the best investments GE ever made," is the way one executive described the whole educational set-up. "We think that a good training program is one of the best answers to the problem of helping your engineers do their best, their most productive—and from the individuals viewpoint the most satisfying—job."

One unlooked for offshoot of the system is the fact that even the educators are sitting up and taking notice of the GE's many and varied engineering education programs to shoe-horn its fledgling engineers into the right jobs.

As a result of this interest, dozens of college mentors have been invited—at General Electric's expense—to GE-ASEE-conducted summer-time clinics and short courses where the programs were explained and demonstrated, and many have even come away converted—eager to adapt some of GE's teaching techniques to the campus.

MORTALITY

. . . *Of Engineering Students*

Ever wonder how many fellows start to study engineering in college and fail to finish? There are some interesting facts and figures on the subject in a recently published study of some 101 engineering colleges and their more than 13,000 1948 freshman entrants. While giving a good cross-section of the engineering colleges of the U. S., the data do not include students engaged in cooperative programs.

Of the entering students covered by the survey, 33 percent were graduated in 2 yrs. or had satisfactorily completed 4 yrs. of a 5-yr. program; 11 percent of the entrants were still enrolled at the end of

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the fourth year and it was expected to graduate most of these. In the 4 yrs. covered, 56 percent had withdrawn or been dropped.

In addition, some of that 33 percent who were graduated in 4 yrs. had academic difficulties. At some time during those years, 26 percent had repeated one or more courses. About 11 percent had attended one or more summer sessions and 12 percent had been on probation for one or more terms. Naturally there was considerable variation among the individual institutions reporting, the graduation ratios for the 50 largest schools ranging from 9 percent to 62 percent.—*Higher Education*

INADEQUATE PEOPLE

. . . *The Unfaced Problem*

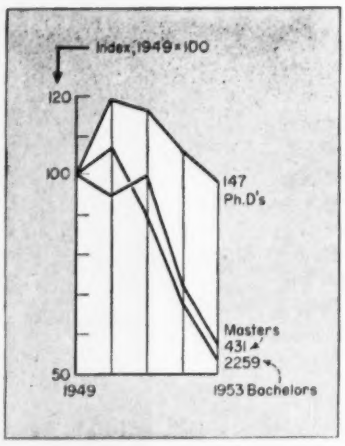
Nearly every organization accumulates its share of people who, though loyal and conscientious, are not adequately filling their job responsibilities. Or at least who do not measure up to the opportunities their jobs represent.

In many cases such people are tolerated until they become a real drag on the organization. Then, perhaps, there is a change in supervision and they're "let out" by a superior who will not put up with their mediocrity. Or maybe they finally slump to a point where they can be tolerated no longer.

Whose fault is it? Theirs, but not theirs entirely. By refusing to face the problem until drastic action was forced, the superiors, themselves, contributed to the situation.

These people should have been told just as soon as management sensed that they were not measuring up. The jolt would have been kindness early in their career. It might have stimulated them to improved performance and increased their value—both to themselves and their organization. Or perhaps it would have encouraged them to look for work more in line with their temperament and capabilities.

Any not-so-adequate personnel in your charge? Start giving them some constructive attention today. —*Management Briefs*



ENGINEERING DEGREES

. . . *Down Considerably*

The U. S. Office of Education has recently released its annual survey of earned degrees conferred in 1953 by U. S. colleges and universities. It reports that engineering degrees granted totaled 24,189—a drop of about 5,000 from the level of the previous year.

Chemical engineering degrees total 2,258—five hundred and one fewer than in 1952. The number of master's degrees dropped from '52's figure of 540 to only 431, while doctorates dipped from 159 to a 5-year low of 147.

This year, the downward trend is expected to continue.

WOULD YOU FIT IN

. . . *On Overseas Jobs*

What a man eats, thinks of foreigners or does with his leisure time may not matter too much to his job performance here at home. For overseas employment, however, personal traits and attitudes have as big a bearing on his chances for success as his technical capacities.

The fellow who has learned to adjust to his environment at home, and who gets along fine, may find life abroad a different kettle of fish and not at all to his liking. It is then that basic defects of character and personality may emerge for the first time and, like checks in the hull of a ship, eventually sink his career.

The major difficulties of working and living overseas—abrupt changes in language, culture, living conditions, climate and associates—are complicated by the "goldfish bowl" factor. Overseas—to a much greater extent than in the United States—a person's job and social life are put in a single package. The people a man works with on the job will probably be the same people he associates with socially. Such constant association places a strain on the inadequate personality.

Personality failures manifest themselves in various ways abroad. A top problem is alcoholism, another is irresponsibility about money and a third is a complete ineptness to adapt to changed conditions.

If you're thinking—or dreaming—of an overseas job, here are some points to check yourself on:

- Rigidity—How adaptable are you? How do you fit into new and changing environments?
- Maturity — How "grown-up" are you? The emotional type? Bothered by fits of deep depression or similar emotional extremes?
- Bias—How critical are you of methods and peoples which differ from your experience?
- Health—How's yours? What type of climate do you prefer? What kind of food, etc.? This is one of the biggest factors contributing to happiness abroad.
- Resourcefulness—Can you improvise? Both on the job and for entertainment? Can you get along by yourself? How well?
- Motivation — Why do you want to work abroad? To escape or to advance? For adventure or for more responsibility?
- Family—How about your wife and children? Can they adjust to life in foreign lands? Suppose you must leave them behind, can you adjust?

The experience of such companies as the Arabian-American Oil Co. has shown that middle-aged men with grown children are the best risks; bachelors, escapists and young married men with babies are the poorest.—*Personnel*

How many bolts are required for a perfect seal?

Should it be 10, 14, 18? Where do you stop?
In the patented K & M "Duoseal" design, just two bolts are required.
And you obtain a tight seal . . . not at 10, 14 or 18 points on
the casing . . . but *a continuous seal at infinite points throughout the entire perimeter.* The result: A completely tight, leakproof
seal that actually grows tighter as control pressure increases.
Furthermore, K & M "Duoseal" saves maintenance time with only two bolts
to tighten. This time saving is a particular consideration
when valves *must* be serviced or inspected in the line.
Within the drawn steel diaphragm casing, the K & M molded neoprene
diaphragm provides an extremely large effective area
that is constant throughout the long stem travel. Virtually the highest
"power factor" available results, with more sensitive response
to control pressure variations, more accurate inner valve positioning and
improved flow regulation through the K & M valve body.

For Complete Automatic Control Valve Data: Write for your copy of the new K & M Valve Engineering Data Catalog, Bulletin CV53. *Also, Available... New* Valve Size Calculator with Low Flow Data.

diaphragm control valves

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CIRCUIT BREAKER, MOTOR STARTER and COMBINATION MOTOR STARTER

UNILETS

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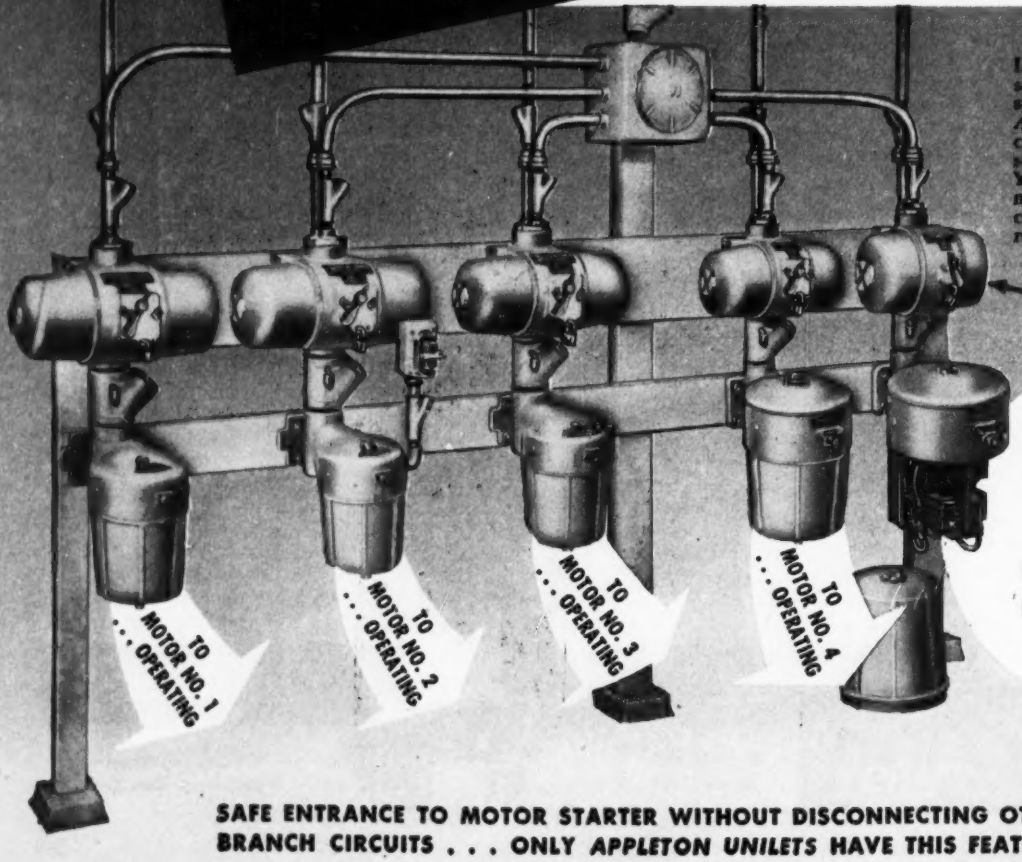


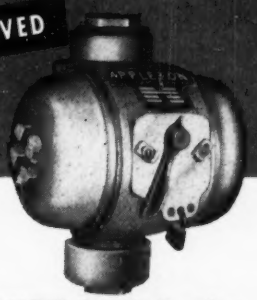
Illustration shows the high safety factor, versatility, and space-saving attributes of *Appleton* explosion-proof circuit breaker and motor starter *Unilet* Combinations. Your own installation needs, no matter what they may be, can also be met with these remarkable new Unilets.

BREAKER LOCKED IN "OFF" POSITION

MOTOR STARTER NO. 5 . . . EXPOSED FOR **SAFE** MAINTENANCE . . . but no "down time" on other operating equipment

SAFE ENTRANCE TO MOTOR STARTER WITHOUT DISCONNECTING OTHER BRANCH CIRCUITS . . . ONLY *APPLETON UNILETS* HAVE THIS FEATURE!

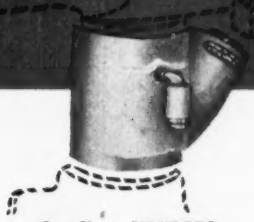
U. L. APPROVED



"CB" Circuit Breaker UNILETS

Assure easy, safe, flexible, and economical installation for protection of service entrance, feeder or lighting, appliance, and branch circuit conductors up to 225 amperes. U. L. Approved individually and in banked groups up to three for forms 1 and 2 without using dividing seal.

U. L. APPROVED



Sealing UNILETS

Available for use as explosion-proof seal where needed on circuit breaker and motor starter Unilets. This Sealing Unilet is furnished on all Combination Motor Starters, and when properly sealed permits safe entrance to a motor starter in single or banked combination installations, without disconnecting other branch circuits.

U. L. APPROVED

"LS" Motor Starter UNILETS

For 3-phase induction motor control up to 100 H.P. at 600 volts maximum. Lightweight construction of larger sizes eliminates need for heavy lift equipment . . . assures easy, time-saving, inexpensive installation. Also made for reversing and two-speed motors.

The greatest advance in explosion-proof design in years!

● You expect more from *Appleton,* and you get it! The proof lies in these completely new and different *Appleton* circuit breaker and motor starter *Unilets.* Alone or in combination, their design, construction, and performance give you maximum safety, unparalleled ease of wiring, installation and maintenance, and initial and long-term money savings not available with any other equipment! You'll find their exclusive features invaluable on any hazardous-location motor control or power lead-in installation, large or small, indoors or outdoors, where tricky wiring, corrosive and flammable atmospheres, dust, or weather difficulties appear insurmountable. Where absolute safety is required day in and day out and every minute of the day, you can place complete confidence in *Appleton Unilets.*

IMPORTANT ADVANTAGES

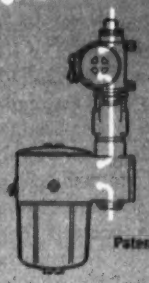
- **FIRST to be U. L. Approved for BANKED Circuit Breaker Grouping**
- **Combinations Meet U. L. Requirements through Approval of Components**
- **FIRST to Achieve Safe Entrance to Motor Starter of a Combination without Shutting Off Other Branch Circuits**
- **Full 7-Thread Explosion-Proof Protection . . . No Bolts to Strip or Flanges to Nick**
- **Unmatched Accessability for Easiest Wiring and Servicing on Every Job**
- **Light-Weight Construction for Easy Installation without Heavy Lift Equipment**
- **Quick Interchange on All Leading Makes of Circuit Breakers and Motor Starters**
- **Flexible Field Set-ups Assured with Single and Duplex Male and Female Hub Adapters**

BANKED CIRCUIT BREAKER GROUPING

Male to female hubs permit easy grouping. Cuts costs, streamlines panel set-ups, assures coordinated control without sacrificing safety. U. L. Approved up to groups of three in smaller size Unilets.

OVER-SIZE CONDUIT and CONDUCTORS

May be run with hub adapters for subsequent installation of higher rated breakers without replacing complete Unilet or existing conduit.



VERTICAL "STRAIGHT-THRU" DESIGN

Simplifies wire pulling, saves time. Ample working space eliminates need to remove breaker mechanism from enclosure, yet assures clean, safe wiring.

Patent Applied For

PUSH-BUTTON and PILOT DUTY CONTROL

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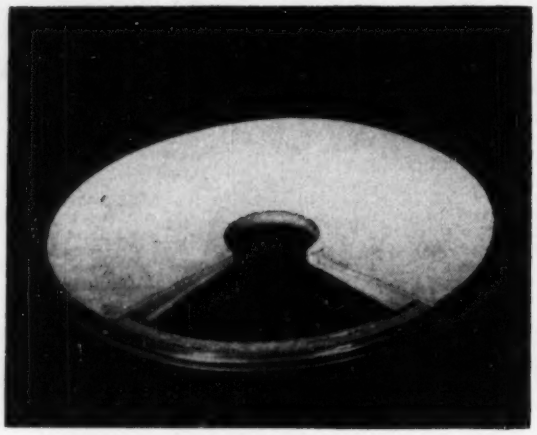


Fig. 1—Fuming nitric acid filter element

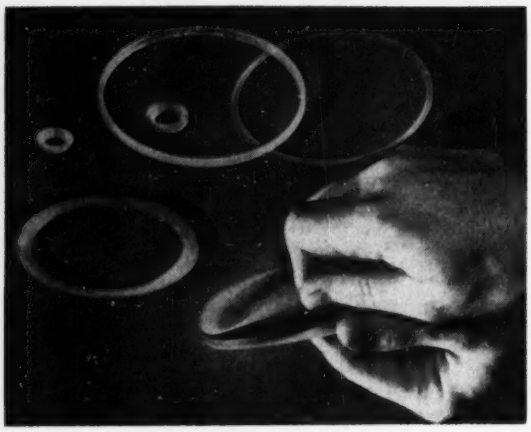


Fig. 2—Sheathed gaskets, "O" and wedge rings

Polytrifluorochloroethylene for Corrosive Service

This relatively new thermoplastic has many favorable characteristics which lend themselves to diversified uses in chemical processing.

JULES A. JUPA

NOTE: *Although the information in this article applies to Kel-F specifically, most of it is typical of trifluorochloroethylene polymers in general. Kel-F is a product of the M. W. Kellogg Co.*—EDITOR.

Trifluorochloroethylene polymers are relative newcomers to the field of corrosion control. High polymers of trifluorochloroethylene were developed during World War II for the Atomic Energy program which demanded materials of construction possessing an extraordinary degree of chemical and thermal stability.

First commercial production of polytrifluorochloroethylene plastic was undertaken by the M. W. Kellogg Co. at Jersey City, N. J., in 1947. Due to high demand for polymers of this type, production facilities have been rapidly increased. Since its initial production, trifluorochloroethylene polymer has been successfully employed in an ever-increasing number of critical applications in the chemical, electronic and equipment fields.

JULES JUPA *is an engineer with the M. W. Kellogg Co., Jersey City, N. J.*

WHAT IT IS

The plastic is essentially a polymerized fluorine-chlorine substituted ethylene, the halogens being present in the ratio of three to one respectively. It is currently produced in the form of molding powders, dispersions, oils, greases and waxes. The polymer's chemical inertness, high dielectric strength and zero water absorption may be attributed to its fluorine constituent.

Chlorine contributes to its transparency, is in part responsible for its excellent mechanical properties and, most important of all, permits this plastic to be molded and fabricated into useful articles by standard production equipment.

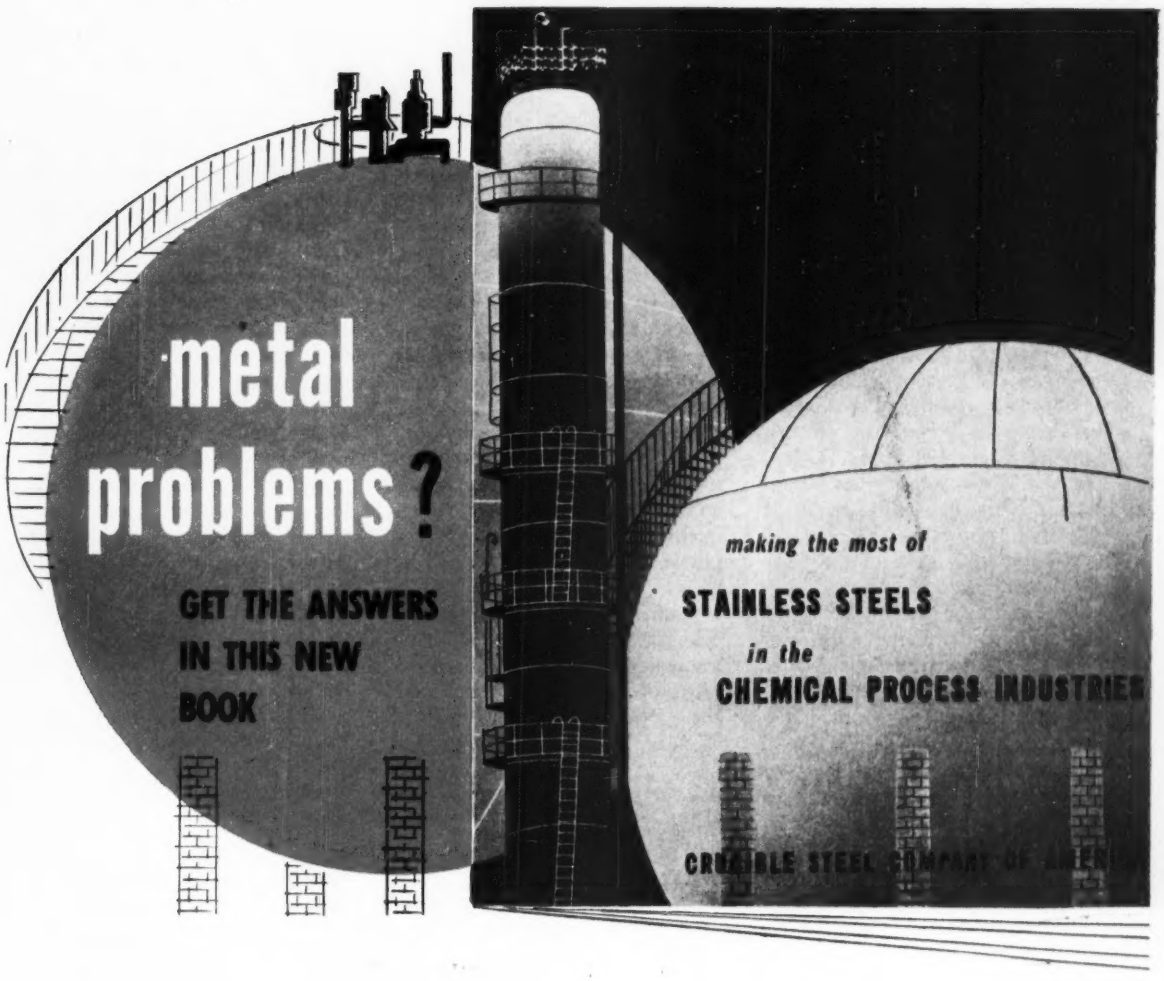
Its most prominent applications to date are gaskets, seals, containers, fittings, diaphragms, liners, filters and coatings for corrosive and thermal service.

PROPERTIES

The material is currently being produced in the form of high and low density molding powders ranging in molecular weight from 75,000 to 110,000. As produced, it is white and amorphous with a specific gravity of 2.1 and an apparent bulk factor of 28.8 to 91.0 cu. in./lb. depending on particle size. In the molded form it may be used at temperatures from subzero to well over 300 deg. F. under severe thermal cycling, mechanical stress and in contact with water or highly active corrosives.

Chemical Resistance—One of the outstanding properties of the polymer is its chemical resistance to the most corrosive agents. Fuming nitric acid, hydrogen fluoride, peroxides, concentrated and dilute mineral acids, alkalis and organic solvents are but a few examples. A noteworthy use is in pressure filters for fuming nitric acid where it is used in porous form (Fig. 1).

In the case of a few hydrocarbons, particularly the highly halo-



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genated hydrocarbons, some absorption and swelling may take place, but in most cases this process is reversible and in most cases this does not preclude use of the polymer with these materials. Most classes of compounds do not swell the plastic more than a few tenths of 1 percent at room temperatures. The chief exceptions are anhydrous chlorine (12 percent), ethyl ether (4 percent) and highly chlorinated or fluorinated compounds (for example, trichloroethylene, 2 percent). The polymer is subject to attack by molten alkali metals at elevated temperatures.

Compressive Strength—Trifluorochloroethylene polymer's exceptional resistance to corrosives is just one part of the unique balance of properties which recommend it for structural use in corrosion control. For the amorphous plastic has a compressive strength of 30,000 psi. and a good impact resistance. It's high compressive strength (for a plastic) is indicative of the material's low cold flow properties—utilized in gasket, seal and barrier applications as illustrated in Fig. 2. Although applications are few and highly specialized, the compressive strength of 30,000 psi. may be increased to 80,000 psi. by heat treatment, a phenomenon also unusual among plastics.

Bearing loads of 8,000 psi. result in only a 4 to 5 percent permanent set, demonstrating the plastic's good resistance to "cold flow," a quality important in its many diaphragm, "O" ring and packing uses.

Resistance to Thermal Shock—The plastic has good resistance to thermal shock exhibiting satisfactory properties over a range of more than 700 deg. F.—from a high of 390 deg. F. to a low of minus 320 deg. F., the boiling point of nitrogen. In certain molded forms and under certain conditions, it has been employed successfully at temperatures close to absolute zero (minus 460 deg. F.).

Dielectric Properties—The polymer has excellent dielectric properties, offering insulation resistance of 15,000 to 25,000 v. under thermal cycling and high humidity. Electrical properties are enhanced by the plastic's zero water absorption, non-wetting and non-adhesive properties which prevent grounding due to surface water, fungus, corona formation or flash-over. Extended arc resistance, non-carbonization at elevated temperatures and non-flammability are additional characteristics which make the polymer superior to most plastic materials.

Water Absorption—Unlike most thermoplastics, the polymer has

Table I—Physical and Mechanical Properties

Properties	ASTM Test Method	Unit of Measure	Results
Specific gravity	D792-48T	.....	2.1
Apparent bulk factor	.....	Cu. in./lb.	28.8–91.0
Refractive index	D542-42	n_D^{25}	1.43
Tensile strength, 77°F	D638-46T	psi.	4,600–5,700
248°F	D638-46T	psi.	460–570
Tensile strength (oriented film and fibre)	.....	psi.	30,000–50,000
Yield strength, 0.2% offset, 77°F	D638-46T	psi.	3640
Elongation	D638-46T	%	28–36
Modulus of elasticity, 77°F			
Tensile	D638-46T	psi.	$192–226\times10^3$
Flexural	D790-45T	psi.	182×10^3
Compressive	D695-44T	psi.	$177–191\times10^3$
Compressive strength, 77°F	D695-44T	psi.	32,000–80,000
Flexural strength, 77°F	D790-45T	psi.	8,200
158°F	D790-45T	psi.	1,500
Stiffness, #300 NST Grade			
minus 297°F	D747-48T	psi.	810×10^3
minus 148°F	D747-48T	psi.	500×10^3
32°F	D747-48T	psi.	250×10^3
212°F	D747-48T	psi.	22,000
302°F	D747-48T	psi.	4,500
Impact strength, Izod, notched, 77°F	D256-47T	Ft. lb/in. of notch	3.62
Outdoor aging, one year	.....	.....	No detectable change
Rockwell hardness	D785-48T	R scale	111–115
Durometer hardness	D676-47T	D scale	80
Abrasion resistance			
59.9946 gm. heat treated	Fed. Spec. L-P-406-a method 1091	Loss in gm/1000 cycles	0.0048
57.3753 gm. quenched	Fed. Spec. L-P-406-a method 1091	Loss in gm/1000 cycles	0.0175
Thermal conductivity	.....	Cal/cm²/sec/°C/cm.	1.44×10^{-4}
Thermal conductivity	.....	Btu/ft²/hr/°F/in.	0.418
Specific heat	.....	Cal./gm./°C.	0.216
Thermal coefficient of linear expansion			
—80° to 20°C.	D696-44	In./in./°C.	4.5×10^{-4}
20° to 150°C.	D696-44	In./in./°C.	7×10^{-4}
Resistance to heat (continuous)	.....	°F.	390
Water absorption	D570-42	%	0.00
Burning rate	.....	.....	Nil
Effect of sunlight	.....	.....	None
Effect on metal inserts	.....	.....	Inert
Machining qualities	.....	.....	Excellent
Clarity	.....	.....	Transparent to translucent
Color possibilities	.....	.....	Unlimited
Volume resistivity (50% relative humidity and 25°C.)	D257-46	Ohm-cm.	1.2×10^{16}
Dielectric strength	.....	Short-time ⅛" v./mil	2500
	D149-44	Step by step ⅛" v./mil	390
	D149-44	Step by step 0.030" v./mil	1,200
	.....	Step by step 0.005" v./mil	5,000
Arc resistance	D495-42	sec.	>360

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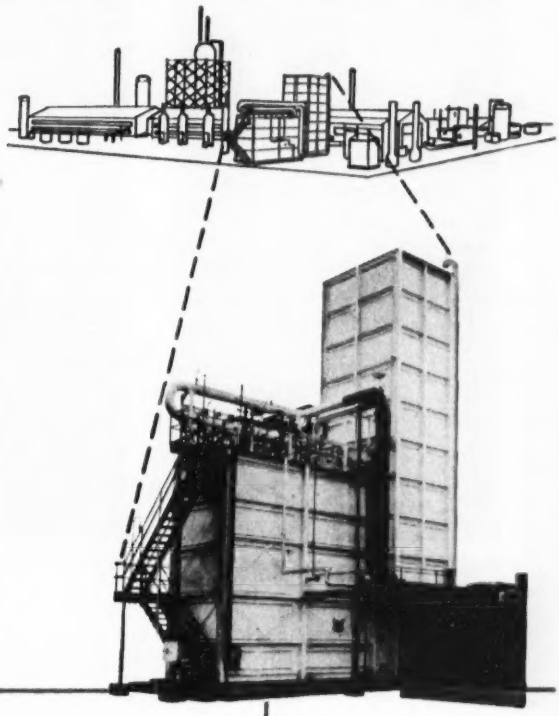

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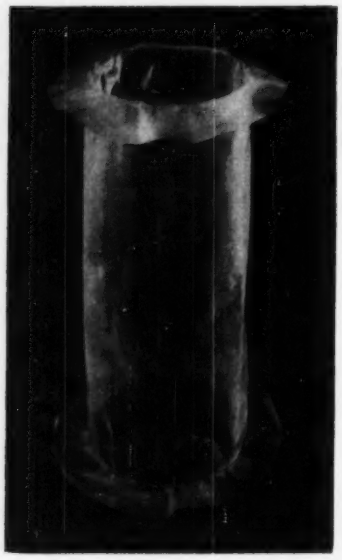

Fig. 3—Non-porous liners for piping

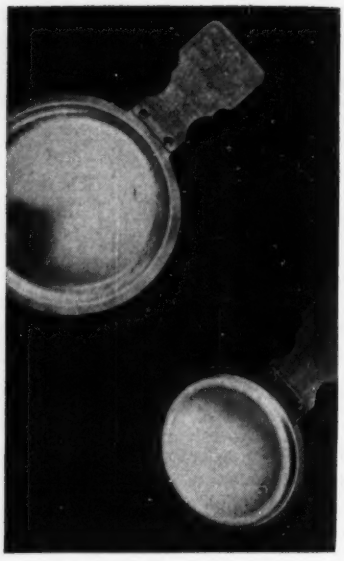

Fig. 4—Coating on rupture disk

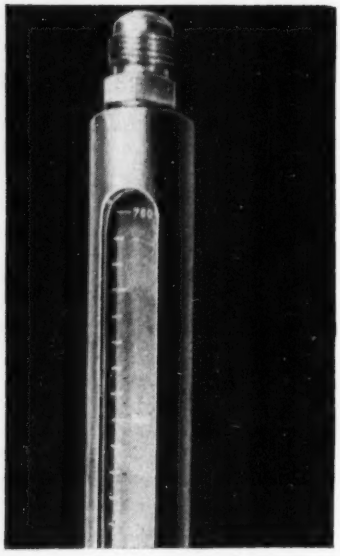

Fig. 5—Flowmeter for HF

zero water absorption, its dimensional stability being unaffected by direct contact or immersion in water. Continuous tests on moisture vapor transmission through extruded film (3 mil) over one month's time show that the fluorocarbon film remains impermeable under conditions of 95 percent relative humidity at 100 deg. F. Tests with air and a number of chemicals show that the polymer film also has low permeability to these agents.

Obvious utilization of these properties is in chemical drum and pipe liners (Fig. 3) which are in successful use today. A 5 to 8 mil thickness of film permits the use of carbon steel instead of expensive alloys in both cases, even where abrasion is present. The unique balance of chemical, mechanical and physical properties of the polymer also apply to "baked-on" coatings of the polymer dispersion used as a protective lining or coating for plant equipment such as vessels and pumps (Fig. 4).

Transparency — Amenability of the polymer to heat treatment makes possible the production of transparent sheet and molded products which have the same properties as the original resin plus the added advantage of light transmission. Excellent use of this transparent material is made in windows and sight glasses for corrosive applications where a strong, unbreakable, yet transparent material is desirable. Fig. 5 illustrates its use in precision flow meters for hydrofluoric acid process lines.

FABRICATING METHODS

The excellent flow characteristics of the polymer permit its molding and fabrication into products using existing equipment. The molding powders are handled readily by extrusion, compression, injection, transfer equipment designed to operate in the temperature range between 450 and 650 deg. F.

Temperature controls are maintained on all parts of the equipment in contact with the resin so that thermal degradation (with resultant loss in desirable properties) is kept to a minimum. Under actual operating conditions, a quality control test is used to measure degradation during production.

In addition to molding, heat forming and other fabricating techniques are employed with this material in obtaining specified products. Table II represents the type of material that is supplied to those users who wish to produce their own finished products.

Table II—Forms Available

Molded sheet stock—1/64 to ½ in. thick up to 60 in. diameter.
Extruded film—0.002 to 0.010 in. thick lay-flat tubing 40 in. wide when split
Extruded rod—up to 1 in. diameter in specified lengths
Molded rod—to 4 in. diameter in lengths up to 24 in.
Extruded tube—up to 2 in. diameter in specified lengths and wall thicknesses
Extruded strip—0.010 to 0.125 in. thick, 2 to 4 in. widths in specified lengths
Extruded wire coatings, monofilaments, specialty compositions and colors

Inertness of the trifluorochloroethylene polymer and freedom from plasticizers permit the molding of metallic and non-metallic inserts into any finished product without danger of degradation of either the plastic or corrosion of the insert. Although colored polymer is available only on a limited basis as yet, an unlimited number of color possibilities in the finished form are possible because the resin may be compounded with inert fillers and pigments.

Size of molded parts is limited by the capacity of equipment designed for operation in the specified temperature range. Some parts, such as an electronics container or "pot" have been molded to a weight of 6 lb. in a single-shot operation. Size limitations can, in many cases, be overcome by coating or liners of the polymer.

Use of extruded film, sheet and plate offers a latitude in the size

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of product possible. Using physical heat or electronic sealing techniques, chemical bags and equipment liners can be made as large as desired for a particular application from the extruded film. Tower liners, 4 ft. in diameter and 30 ft. in length, are now in use. Other liners and protective covers for corrosion installations of much larger size are now under test. In the "rigid" unsupported plastics field, newly-developed "hot-gas-welding" techniques promise to open new fields of application for equipment fabricated from rigid and heavy-section plastic.

New developments in anti-corrosion lining and coatings for chemical equipment, using polymer-glass fiber laminations and refinements in dip and spray application of high-polymer dispersions for "baked-on" coatings, promise to open up more fields of application for these corrosion resistant, tough plastics in the chemical industries.

Table III—Chemical Resistance and Dimensional Stability of Unplasticized Quenched Polytrifluorochloroethylene.

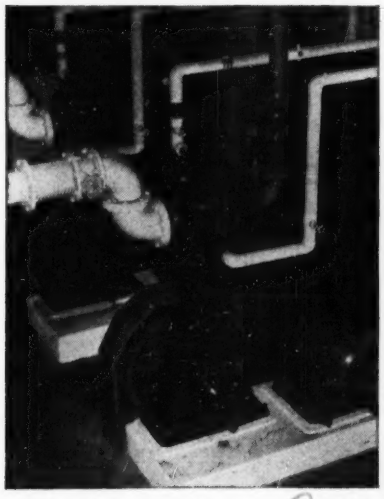
	Percent Change at 25°C., 7 Days					Percent Change at 25°C., 7 Days			
	Sample Dimensions, In.			Weight		Sample Dimensions, In.			Weight
Corrosive	Thick	Width	Length	Change	Corrosive	Thick	Width	Length	Change
Acetic acid	0.16	0.05	0.00	0.0	Freon 113	1.2	0.1	0.0	1.2
Acetic acid 5%	—0.16	—0.03	—0.03	0.0	Formic acid	....	....	....	0.0
Acetic anhydride	0.16	0.02	—0.03	0.0	Furan	4.1	0.4	0.1	2.4
Acetone	0.24	-0.04	0.00	0.1	Halowax 1000	0.0	—0.02	0.0	0.0
Acetophenone	0.00	—0.04	0.00	0.0	n-Heptane	—0.08	—0.07	—0.07	0.0
Acetyl chloride	....	....	....	0.1	Hollingshead H-2 (7 days)	....	....	....	....
Allyl chloride	....	....	....	0.2	Hydrochloric acid 10%	—0.16	—0.05	—0.07	0.0
Ammonia, anhydrous	....	....	....	0.0	Hydrofluoric acid (anhy.)	....	....	....	0.0
Ammonium hydroxide 10%	—0.50	—0.09	0.00	0.0	Hydrofluoric acid 50%	0.08	—0.09	—0.07	0.0
Amyl acetate	0.08	—0.04	—0.07	0.0	Hydrogen peroxide 3%	0.0	—0.01	—0.03	0.0
Amyl acid phosphate	....	....	....	0.0	Hydrogen peroxide 30%	....	....	....	0.0
Aniline	0.00	0.00	—0.03	0.0	Isopropyl ether	....	....	....	0.2
Antimony pentachloride	0.00	0.02	0.00	0.0	Methanol	0.08	0.02	—0.03	0.0
Aqua regia	....	....	....	0.0	Methyl acetate	1.8	0.1	0.0	1.0
Aroclor 1242	0.00	0.01	0.03	0.0	Methylal	2.5	0.4	0.1	1.3
Aroclor 1248	0.00	0.03	0.00	0.0	Methallyl chloride	0.25	0.06	0.10	0.1
Aroclor 1254	0.00	0.03	—0.03	0.0	Methyl n-butyrate	1.6	0.2	0.0	0.8
Benzaldehyde	0.16	0.00	—0.07	0.0	Methylene chloride	....	....	....	0.2
Benzene	0.56	0.03	0.0	0.2	Methyl ether	6.9	5.4	4.9	6.4
Benzonitrile	....	....	....	0.0	Methyl ethyl ketone	....	....	....	0.2
Benzyl alcohol	0.16	0.00	0.00	0.0	Methyl formate	....	....	....	0.1
Benzoyl chloride	....	....	....	0.0	Methyl propionate	2.8	0.1	0.0	1.4
Bromine	0.00	—0.04	—0.03	0.0	Mineral oil	0.08	0.02	0.0	0.0
Bromobenzene	0.08	0.01	0.00	0.0	Naphtha solvent	0.08	0.01	—0.03	0.0
Butyl acetate	....	....	....	0.3	Nitric acid	0.16	0.0	0.0	0.0
Butyl alcohol	0.0	0.01	0.0	0.0	Nitric acid fuming 89-95%	....	....	....	0.0
n-Butyl ether	0.17	0.04	0.00	0.0	Nitric acid 10%	—0.24	—0.08	—0.03	0.0
n-Butyl sebacate	—0.08	0.00	0.00	0.0	Nitrobenzene	0.0	0.01	—0.03	0.0
Calcium chloride (sat)	....	....	....	0.0	Nitromethane	0.0	—0.02	—0.07	0.0
Carbitol acetate	....	....	....	0.0	Oleic acid	—0.08	—0.07	—0.07	0.0
Carbon disulfide	0.16	—0.02	—0.03	0.1	Pentachloroethane	....	....	....	0.0
Carbon tetrachloride	0.5	0.0	0.1	0.4	Perchloric acid (14 days)	....	....	....	....
Cellosolve acetate	....	....	....	0.0	Perfluorotriethylamine	....	....	....	0.0
Chlorine anyhydrous (147 hrs.)	6.6	5.0	4.8	12.3	Piperdine	....	....	....	0.0
1-Chloro-1-nitropropane	—0.16	—0.02	—0.03	0.0	Potassium hydroxide 10%	....	....	....	....
2-Chloropropane	....	....	....	0.3	Propylene chloride	....	....	....	0.0
o-Chlorotoluene	....	....	....	0.0	n-Propyl acetate	1.1	0.2	0.1	0.6
p-Clorotoluene	....	....	....	0.0	n-Propyl ether	....	....	....	0.3
Chlorotrifluoroethylene (8° to 25°C)	9.5	2.2	1.0	9.1	n-Propyl formate	....	....	....	0.1
Chlorotrifluoroethylene liq. polymer	....	....	....	0.0	n-Propyl propionate	0.6	0.2	0.0	0.4
Chromic acid cleaning solution	....	....	....	0.0	Pyridine	0.08	0.05	—0.03	0.0
Cresol	—0.08	—0.01	0.0	0.0	Santicizer B-16	....	....	....	0.0
Cyclohexanone	....	....	....	0.0	Santicizer E-15	....	....	....	0.0
Dibutyl phthalate	0.0	0.0	0.03	0.0	Santicizer M-17	....	....	....	0.0
Dibutyl sebacate	....	....	....	0.0	Santicizer 8	....	....	....	0.0
1,2-Dichlorobutane	....	....	....	0.0	Santolube 31	....	....	....	0.0
3-Dichloroethyl ether	0.17	0.08	0.0	0.0	Sodium carbonate 2%	—0.16	—0.11	—0.03	0.0
1, 2-Dichlorohexafluorocyclobutane	....	....	....	0.1	Sodium chloride 10%	—0.08	—0.08	—0.03	0.0
Dichloropropylene	0.16	0.01	0.0	0.0	Sodium hydroxide 1%	—0.16	—0.10	—0.03	0.0
2,4-Dichlorotoluene	....	....	....	0.0	Sodium hydroxide 10%	—0.16	—0.14	—0.03	0.0
3,4-Dichlorotoluene	....	....	....	0.0	Stannic chloride	0.08	—0.02	0.0	0.0
Dicyclopentadiene	0.0	—0.01	0.03	0.0	Sulfuric acid	0.16	0.0	—0.03	0.0
Diethylamine	4.5	0.4	0.1	1.9	Sulfuric acid 3%	—0.40	—0.05	—0.07	0.0
Diethyl carbitol	0.16	0.04	0.0	(0.14)	Sulfuric acid 30%	—0.08	—0.04	—0.07	0.0
Diethyl cellosolve	1.7	0.1	0.0	0.8	Sulfuric acid 20% free SO_3	....	....	....	0.0
Diethylenetriamine	....	....	....	0.0	Sulfur dioxide, anhydrous	....	....	....	0.1
Dioxane	0.08	0.03	0.0	0.0	sym-Tetrachloroethane	—0.24	—0.05	0.0	0.0
Ethanol 50%	—0.16	—0.04	—0.01	0.0	Tetrachloroethylene	0.8	0.0	—0.1	0.8
Ethanol 95%	—0.08	—0.03	—0.03	0.0	Toluene	0.9	0.1	0.1	0.4
Ethyl acetate	2.3	0.2	0.1	1.2	1,1,1-Trichloroethane	....	....	....	0.1
Ethyl n-butyrate	0.9	0.1	0.0	0.5	1,1,2-Trichloroethane	0.08	0.01	—0.03	0.0
Ethyl ether	8.0	1.2	0.5	3.8	Trichloroethylene	2.9	0.2	0.1	2.3
Ethyl formate	....	....	....	0.2	1,2,3-Trichloropropane	....	....	....	0.0
Ethyl propionate	1.8	0.1	0.1	1.0	Trichloropropane	—0.24	0.0	0.0	0.0
Ethylene chloride	....	....	....	0.0	Triethylamine	....	....	....	0.2
					m-Xylene	1.0	0.1	0.0	0.4

NOTE: Changes in weight do not indicate chemical reaction but rather absorption. Furthermore, through development of crystallinity by heat treatment it is possible to reduce absorption to a minimum.

It's JOY for OIL-FREE AIR

Above: Joy WNO-112 Oil-Free Compressor

Below: Joy WGO-9 Oil-Free Vertical Compressor



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★ Ease of disassembly facilitates inspection of pistons, rings, cylinder liners and valves.

★ On-the-job-replaceable chrome-plated cylinder liners for hard, smooth, friction-reducing surfaces. Also replaceable crosshead guides.

★ Carbon graphite compression rings designed to compensate automatically for wear.

★ Large, direct air passages and liberal water-jacketing reduce heat of compression and increase ring life.

★ Patented Dual-Cushion valves, all parts of which are made from corrosion-resistant materials.

★ All wearing areas, except carbon rings, are either chrome-plated, surface hardened, or of stainless steel.

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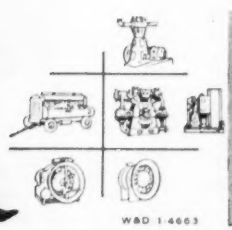

WAD 1-4663

JOY

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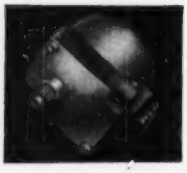
The "inside" story of *ElectroniK* instruments

Maybe you've never seen what's inside the case of an *ElectroniK* instrument. And even if you have, you might not realize how each component has been painstakingly refined to contribute its share to the overall performance and dependability of the instrument. Three of these components in particular—the converter, "Continuous Balance" amplifier and the balancing motor—are key members of the *ElectroniK* team with which you should get acquainted.

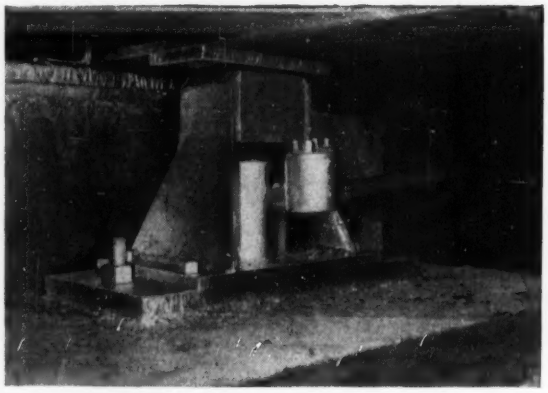
The Converter
is what transforms tiny direct-current signals from the thermocouple or other sensing element into an alternating voltage that the amplifier can conveniently handle. In principle, it is somewhat like the vibrator in your automobile radio. But because it deals with such small bits of electrical energy, it has been designed of carefully selected materials which prevent the introduction of misleading signals into the measuring system. It is hermetically sealed against the effects of dust, humidity and atmospheric pressure change, and is shielded against stray electrical and magnetic fields.

The "Continuous Balance Amplifier"
boosts the incoming signals by millions of times . . . makes them strong enough to operate the balancing motor. Although it looks like part of a radio chassis, few communications circuits could equal it for quality. It uses standard, easily obtained parts, which are operated far below their normal ratings to insure exceptionally long life. The circuit has great stability against drift and pick-up, and is thoroughly temperature compensated.

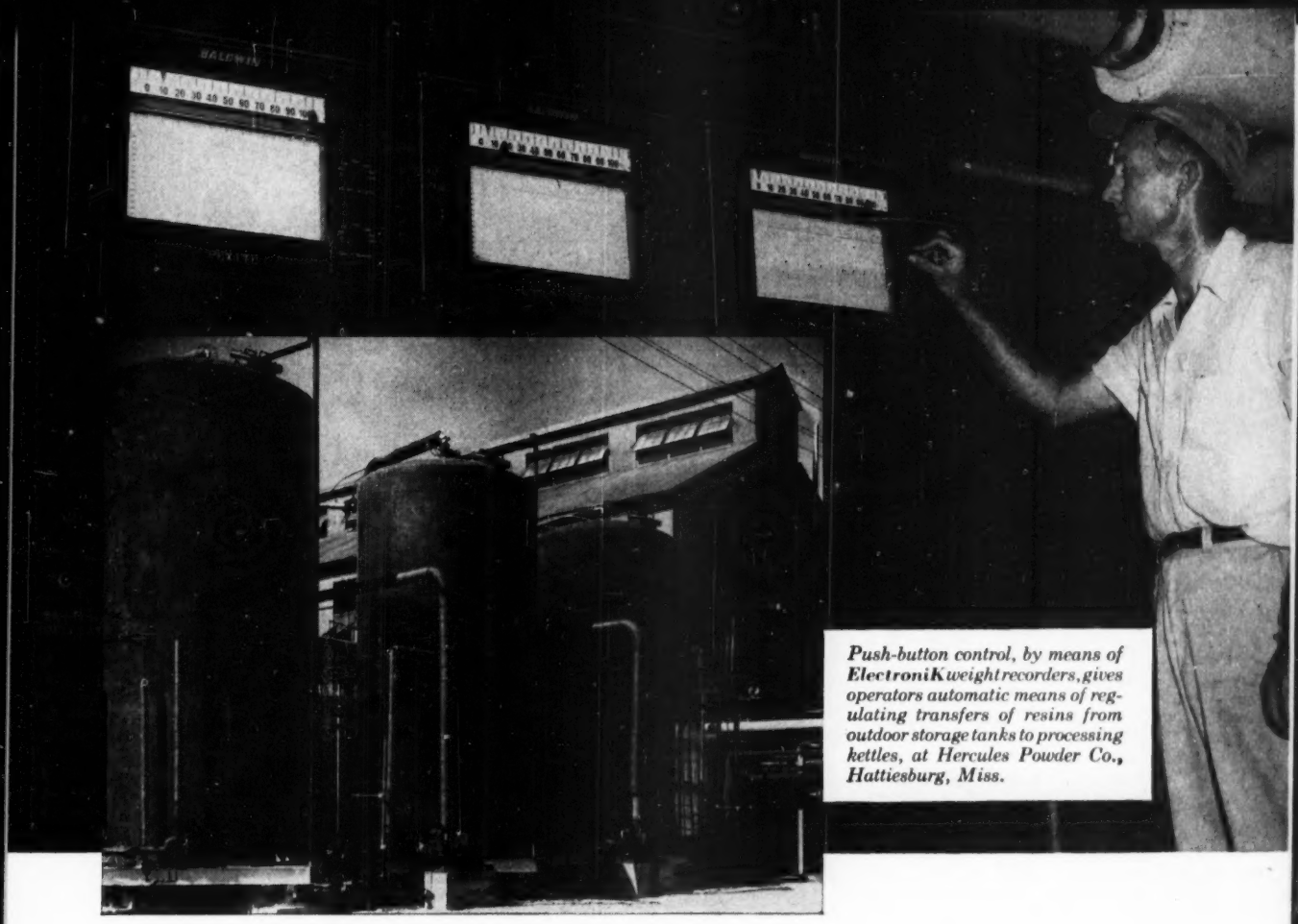


The Balancing Motor
does the work of moving the pointer, recording pen and any control devices that may be incorporated in the instrument. It packs plenty of power into a small space . . . gives ample torque to give fast, accurate positioning whenever the amplifier calls on it. Totally enclosed, the motor is impervious to dust, dirt and changes in mounting position.

Electrical weighing system measures batch



Four Baldwin-Lima-Hamilton SR-4 load cells like this one are built into the pillar mounts of the storage tanks. Connected in series to an ***ElectroniK*** *recorder, they detect total weight of the tank. An adjustment in the instrument cancels out dead weight, to give direct reading of weight of tank contents.*



Push-button control, by means of ***ElectroniK*** *weight recorders, gives operators automatic means of regulating transfers of resins from outdoor storage tanks to processing kettles, at Hercules Powder Co., Hattiesburg, Miss.*

ingredients accurately . . . *automatically*

NEED to measure transfers of materials? The automatic weighing system that Hercules Powder Co. uses for measuring resin ingredients at their Naval Stores plant may give you some new ideas.

The problem here was to transfer the required weights of various viscous liquids from outdoor storage tanks into processing kettles. The answer is electrical weighing by means of a fully automatic system that utilizes Baldwin-Lima-Hamilton SR-4® strain gage load cells and *ElectroniK* strip chart controllers. This system controls weight directly without the complications that go with conventional flow metering.

Each tank is weighed continuously by four load cells mounted under the tank-supporting beams. Output of the load cells is fed to an *ElectroniK* weight recorder. To deliver a given amount of liquid into a processing kettle, the operator sets a selector switch and moves the instrument control index downscale by the required poundage. Pushing a button starts the cycle. Without further attention, the system pumps out the desired poundage of fluid, automatically stops the pump, records the weight delivered and steam-purges connecting pipes.

Through more accurate measurement, this system helps to produce greater quality and uniformity in resin formulas. It saves time and labor, too, by giving a continuing inventory for cost-accounting purposes.

Electronic weighing systems offer endless opportunities for measuring materials in storage, or in motion. Your nearby Honeywell engineer will be glad to discuss the possibilities in your own plant's operations . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for Data Sheet No. 10 18-1a, "Unit Measuring Systems with Baldwin Electric Strain Gages," and for Catalog No. 1531, "*ElectroniK* Controllers."

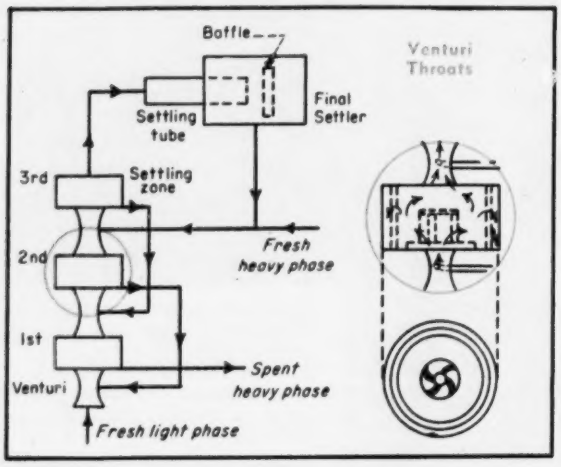
MINNEAPOLIS **Honeywell**

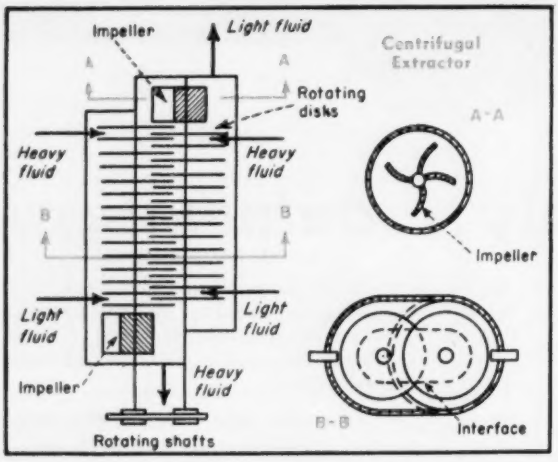
BROWN INSTRUMENTS

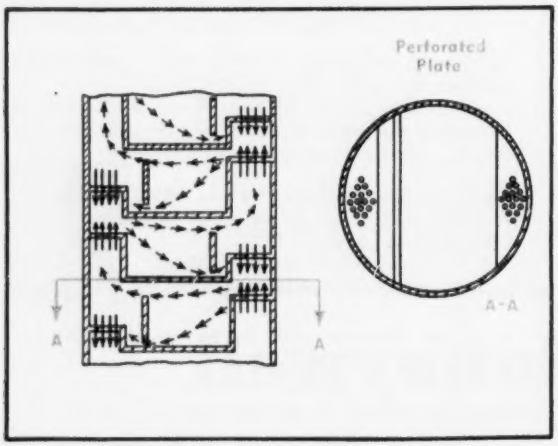
First in Controls

 Melvin Nord, Chemical Engineer & Patent Attorney, Detroit, Mich.

NEW EQUIPMENT PATENTS







Three New Extractors

Take your pick of three novel ways to insure intimate contacting and separation of two-phase systems.

A flurry of activity in the field of liquid-liquid extraction has resulted in three patents of unusual interest.

• U.S. 2,665,975, assigned by Thomas Ng to Standard Oil Development Co., describes countercurrent contacting of two-phase systems through a series of Venturi throats.

• U.S. 2,668,756, assigned by Samuel C. Carney to Phillips Petroleum Co., describes a new centrifugal extractor for separating two-phase systems.

U.S. 2,669,505, assigned by Cyril O. Rhys, Jr. and William E. Stanton to Standard Oil Development Co., describes a novel perforated plate construction for separating two liquids.

▶ **Venturi Throats**—The Venturi countercurrent setup consists of several settling zones connected by Venturi throats. Each settling chamber has several spiral vanes placed across the discharge opening of the Venturi. In addition, each chamber is provided with perforated baffles to speed settling of the heavy phase.

Light fluid enters the bottom of the system, passes through the first Venturi, through the spiral vanes into the first settling zone. Heavy fluid is pumped by the Venturi from the second zone into the first. Centrifugal action of the spiral vanes tends to separate the fluids in this zone by density difference.

The lighter fluid flows from the first zone, through the second Venturi and up into the second chamber. The jet action of the Venturi is used to pump the heavier fluid from the third chamber into the second one. Again centrifugal action of the vanes separates the liquid into two phases.

This process is repeated in as many settling chambers and Venturis as are desired. Final separation of any residual heavy fluid from the lighter phase is accomplished by passing the latter into an enlarged final settling zone.

▶ **Centrifugal Extractor**—The Phillips extractor consists of an elliptical vessel containing a pair of vertical shafts rotating in the same direction. A chamber (of circular cross section) at the top of the

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vessel carries a circular impeller at the upper end of one of the shafts. A series of thin flat metal disks are spaced on the shaft below the impeller.

A similar arrangement is provided at the other side of the vessel, the impeller being at the bottom instead of the top of the shaft. The rotating disks overlap each other. Each disk has a series of openings to allow longitudinal flow of the lighter fluid.

Centrifugal action of the disks causes the lighter fluid to move toward the center of the apparatus and the heavier one to the peripheral region. An interface or neutral zone is established by the rotation of the disks, thus separating the contents of the vessel into two continuous phases—a lighter and a heavier one. Heavy liquid flows down through the vessel, countercurrent to the light fluid, and then passes to the bottom outlet under a controlled back pressure.

As each disk passes through one liquid, it picks up a film of that liquid. This film is then abruptly plunged through the interface into the other liquid. This allows the liquid-liquid extraction to be carried out efficiently without emulsification.

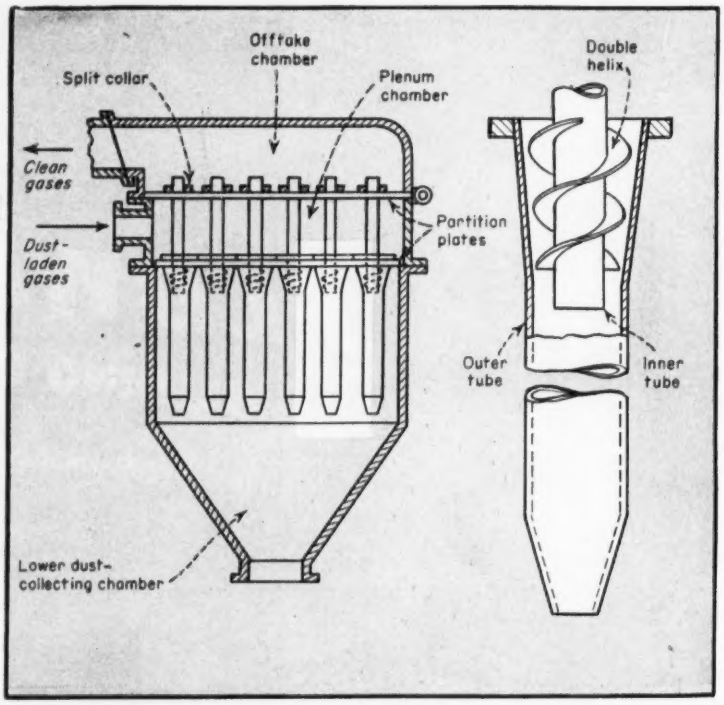
The mixing action is superior to that obtained by drop dispersion because the filmed disks can move through the liquids at a velocity far greater than can be attained by free drops moving under gravitational or centrifugal force.

▶ **Perforated Plate**—Standard Oil's other new tower design consists of plates divided into three steps. The two highest steps of each plate are perforated. The lowest one (and all other portions of the apparatus) is unperforated.

Plates are placed so as to achieve intimate mixing of fluids between the lower perforated step of one plate and the upper perforated step of the plate immediately below. The zone between the lower steps of adjacent plates provides a large settling area for the separation of liquids. A still greater zone between the upper step of one plate and the lower step of the plate below gives the head necessary for the liquids to flow from the perforated plates into the mixing zone.

Plate efficiencies for this apparatus—on hard-to-separate mixtures—are quoted at greater than 50 percent.

An apparatus modification which is applicable to mixtures that are difficult to mix but easy to separate is also described in the patent.



New Design Ups Separator Efficiency

Optimum efficiency with minimum pressure drop are the features of a new cyclone separator design.

The cyclone casing is divided by partition plates into three chambers: lower dust-collecting chamber, intermediate drum-like (plenum) chamber and offtake chamber.

▶ **Tube Construction**—In addition, several separating units are mounted in the cyclone casing. Each unit consists of an outer centrifugal tube and an inner tube. The outer tubes are flanged at the top for coupling to the partition plate.

Vertically adjusted (by split collars) inner tubes pass through partition plate openings and end well within the upper confines of the outer tubes.

Each inner tube carries a double helix extending part way down the tube. The helix imparts a cyclone movement to the dust-laden gas entering the system. Dust particles collect adjacent to the outer wall, dropping into the lower chamber.

Clean gas returns up the inner tubes, flows into the offtake chamber and then out to the atmosphere.

Complete details and results of operating tests are given in the patent.

The new design is described by J. Crites in U.S. 2,667,944, assigned to Combustion Engineering, Inc.

FACTS ON INFRARED FOR THE PROCESS PLANT

Which costs more... waste product? or infrared analyzers?

Infrared analyzers are expensive, but sub-standard products can be even more costly. You can nip waste production runs in the bud by monitoring your process stream with infrared analyzers. Significant changes in stream composition can be detected *immediately*, in time to prevent off-quality material. Once installed, the instruments pay for themselves in a few weeks of operation.

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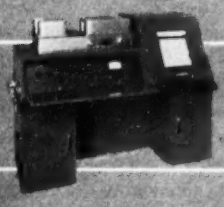
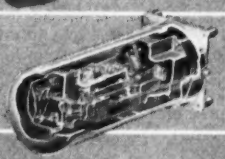
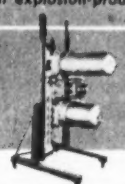


FOR THE PILOT PLANT—*Model 14 Multi-Component Analyzer*— Continuously records the concentration of up to six components in a pilot process stream on a six-minute cycle. Ideal for tracking the effects of temperature, pressure, etc., changes in a pilot stream.



FOR THE PROCESS PLANT—*Model 93 BICHROMATOR* Analyzer* —For continuous control of liquid or gas streams. Records the ratio of any two wavelengths chosen. Thermostatted; enclosed in explosion-proof containers.



FOR THE PROCESS PLANT—*Model 105 TRI-NON* Analyzer* —Highly stable and sensitive. Suitable where there is considerable interference from stream components. Thermostatted; enclosed in explosion-proof containers.

*Trademark The Perkin-Elmer Corporation

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Model 14 ..... Models 93 and 105 .....

NAME .....

TITLE .....

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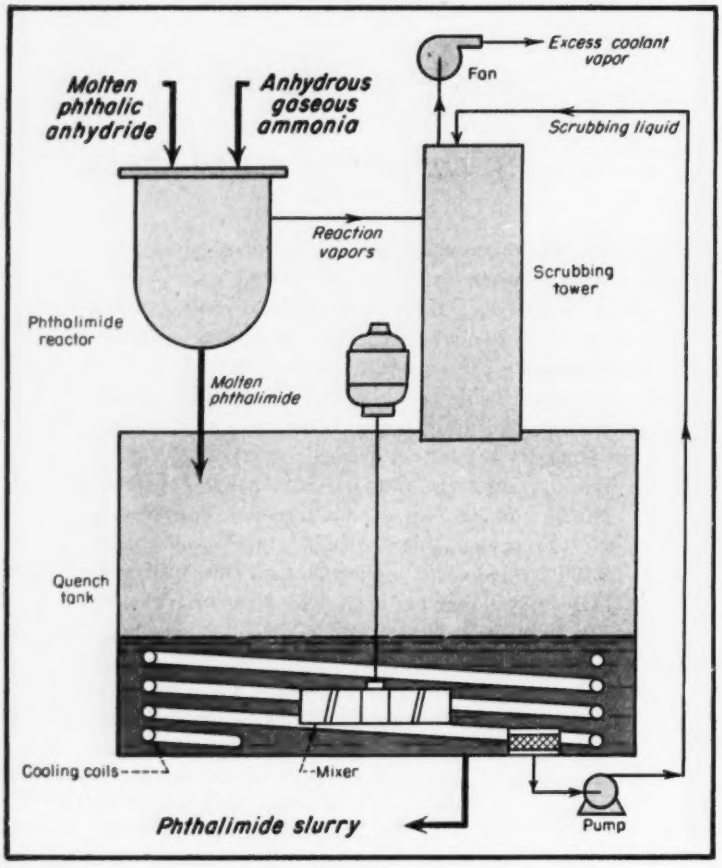

Phthalimide Made the Easy Way

Conventional stumbling blocks routed by new phthalimide process. Quenching molten phthalimide eliminates vaporization and grinding losses.

A new and simple process for the manufacture of phthalimide, a starting material in saccharin and amino acid syntheses, has recently been revealed. Like the preparation of lead shot, the new method hinges on dropping molten material—in this case, phthalimide—into a quenching bath to get a granular product.

▶ **Conventional Problems** – Standard manufacture of phthalimide involves the reaction of gaseous anhydrous ammonia with molten phthalic anhydride until absorption of ammonia ceases and a sample of the molten mass gives the required melting point for pure phthalimide. Solidified product is ground to a powder.

This procedure leads to:

- Dust formation (during grinding) which induces irritation of the eye, nose and throat membranes.
- Loss of end product.

Another process, sublimation of the reaction mass followed by condensation of the sublimate, is not satisfactory either because:

- Heavy, expensive equipment is required.
- Light, fluffy product doesn't pack well, has a low bulk density.
- Heat loss is incurred in phthalimide vaporization.

▶ **How They're Overcome**—The new procedure was designed to eliminate these difficulties.

The process is carried out in an essentially closed system. Phthalimide, previously lost when steam was liberated in the reaction, is recovered in a gas-liquid contact apparatus such as a wet scrubber. When the reaction is complete, molten phthalimide is quenched in a vigorously agitated liquid. The latter is preferably the same as that used in the scrubber.

Using this method, you get a finely divided granular phthalimide produced quickly and effectively. The individual particles are irregular and porous, having a surface area more than twice that resulting from grinding of solid phthalimide.

Contrary to expectations, the process can be carried out with little or no decomposition of phthalimide during quenching. The resulting slurry can either be used for further processing or the phthalimide can be filtered off and dried in conventional equipment.

Dried phthalimide thus prepared is porous, free-flowing and practically dustless. These characteristics are very desirable, especially in further processing of the product to dyestuffs and other intermediates.

▶ **The Reaction**—In the new process, molten phthalic anhydride and ammonia are intimately mixed in a reactor until the reaction is complete. Vapors evolved during the reaction flow to a scrubbing tower. Molten product then flows into a quench tank in which the quenching liquid is agitated and, if desired, cooled by cooling coils.

Vapors released during quenching are drawn up by a fan. Scrubbing liquid (usually the same as the quenching liquid) is supplied, under pressure, to the tower. Liquid and entrained phthalimide discharge

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STATOR INSULATION is doubled in dielectric strength and exceptionally resistant to moisture, oil, chemicals and abrasion.

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BALL BEARINGS are oversize to provide excess load capacity. Pre-lubricated for years of trouble-free service.

INDESTRUCTIBLE ALUMINUM ROTORS. Keyed to the shafts in most frame sizes to prevent looseness under unusual and severe load conditions.

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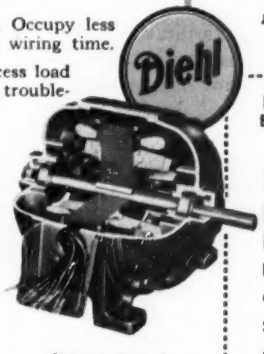

Cutaway view of new Diehl Type "D" Motor

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Electrical Division of THE SINGER MANUFACTURING COMPANY
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Please send me the following bulletins

☐ New Type "D" Motor Bulletin No. CE3304
☐ Consolidated Catalog & Price List No. CE3310

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OTHER INTEGRAL AND FRACTIONAL HORSEPOWER MOTORS ARE AVAILABLE IN A WIDE RANGE OF TYPES AND SIZES

into the tank. The latter serves as a supply reservoir for the scrubbing tower. The system is closed except during quenching when the fan is operated to discharge excess coolant vapor.

U. S. 2,668,326 has been assigned by the inventor, George F. Schlaudecker, to Maumee Development Co.

Take The Bugs Out Of Phenol Production

Fewer by-products and less corrosion. These are the claims of a new variation on an equally new commercial process for the production of phenol and acetone from cumene hydroperoxide.

The method hinges on the use of a non-acidic (rather than an acidic) catalyst in the decomposition of the hydroperoxide to phenol and acetone. This catalyst exerts no corrosive action on plant equipment. Moreover, it does not act as a condensing agent between the reaction products, phenol and acetone. Hence the formation of undesirable resinous by-products is avoided.

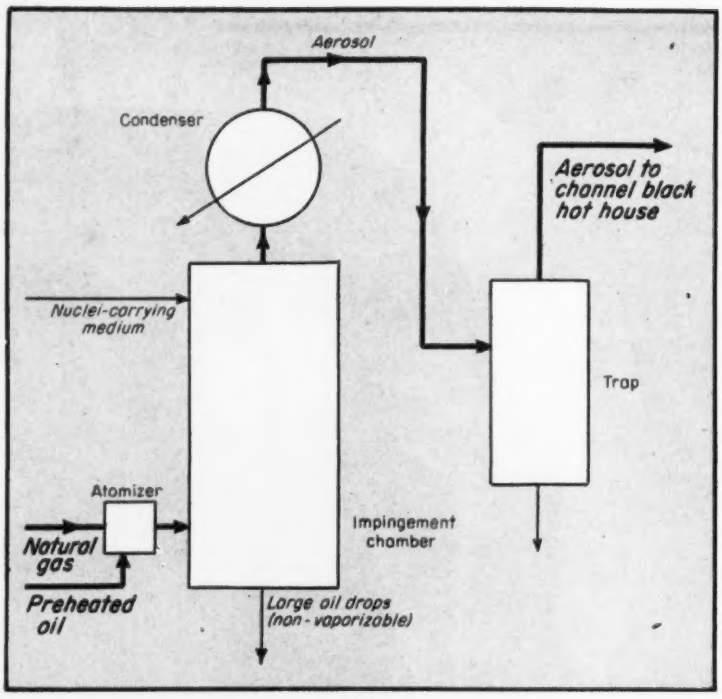
Any one of the solid elements of sub group b in groups V and VI of the periodic table can serve as catalyst. Of these, sulfur and phosphorus give the best results.

Powdered catalyst is used in solution or in suspension. The solvent can be the same as that used for the cumene hydroperoxide.

The reaction is carried out at such a temperature that the acetone formed can escape at the boiling temperature of the solvent. This temperature is regulated by maintaining a vacuum on the system. The exothermic fission starts rapidly. It is controlled by boiling the solvent under reflux. When the reaction is complete, solvent and phenol are distilled.

Detailed examples are cited in the patent. In one instance, yields of acetone and phenol were 80 percent and 85 percent respectively.

Igor Scriabine, the inventor, has assigned his patent, U. S. 2, 668,-859, to Societe des Usines Chimiques Rhone Poulenc.



Yields Soar With Aerosols

Tire treads and printing inks may be the chief beneficiaries of a novel process for the simple and inexpensive production of carbon black in greatly increased yields.

Key to the new method is the use of a liquid hydrocarbon-natural gas aerosol (rather than natural gas alone) as the starting material.

▶ **Aerosol Formed**—Preheated oil and natural gas feed to an atomizer and thence to an impingement chamber where further atomization occurs. The chamber is maintained at a temperature high enough to flash vaporize oil droplets carried in the gaseous stream. Those droplets too large to be vaporized drop to the chamber bottom and are drawn off through an outlet pipe.

Aerosol characteristics can be improved by introducing a nuclei-carrying medium such as vaporized ammonium or sodium chloride into the impingement chamber.

▶ **Carbon Black Deposited**—After the aerosol forms, it flows to an overhead condenser, through a trap and into burner pipes of a channel black hot house.

These pipes contain shielded, spaced burner tips which direct hydrocarbon flames against the surface of overhead channel irons. The carbon black thus deposited is swept, by the longitudinal movement of the channel iron, over scrapers and into a collecting trough. A screw conveyor removes the carbon black from the trough.

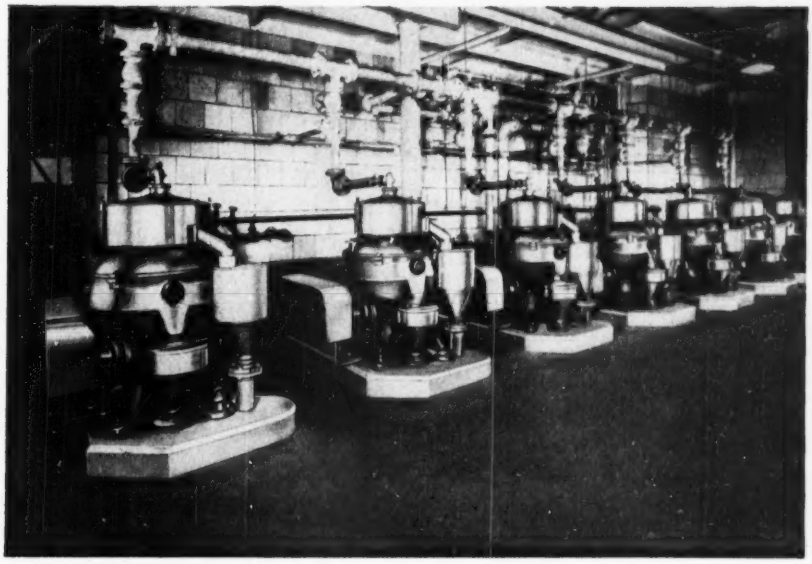
How does the new technique compare with conventional practices? It offers:

- Higher yields than channel processes.
- Better quality product than furnace processes.

Test data are cited in the patent. Greatest improvement over straight natural gas was 45 percent.

The patent, U. S. 2,665,195, has been assigned by the inventor, Merrill E. Jordan, to Godfrey L. Cabot, Inc.

Solving YOUR Separation Problems is De Laval's Business



Battery of De Laval Separators concentrating gluten.

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Mead Corporation
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Oscar Mayer & Co.
Standard Brands, Inc.
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De Laval Separators and Clarifiers, replacing filters and settling tanks, have quickly paid for themselves and are now earning daily dividends for many of America's most important manufacturers of chemicals, pharmaceuticals and food products.

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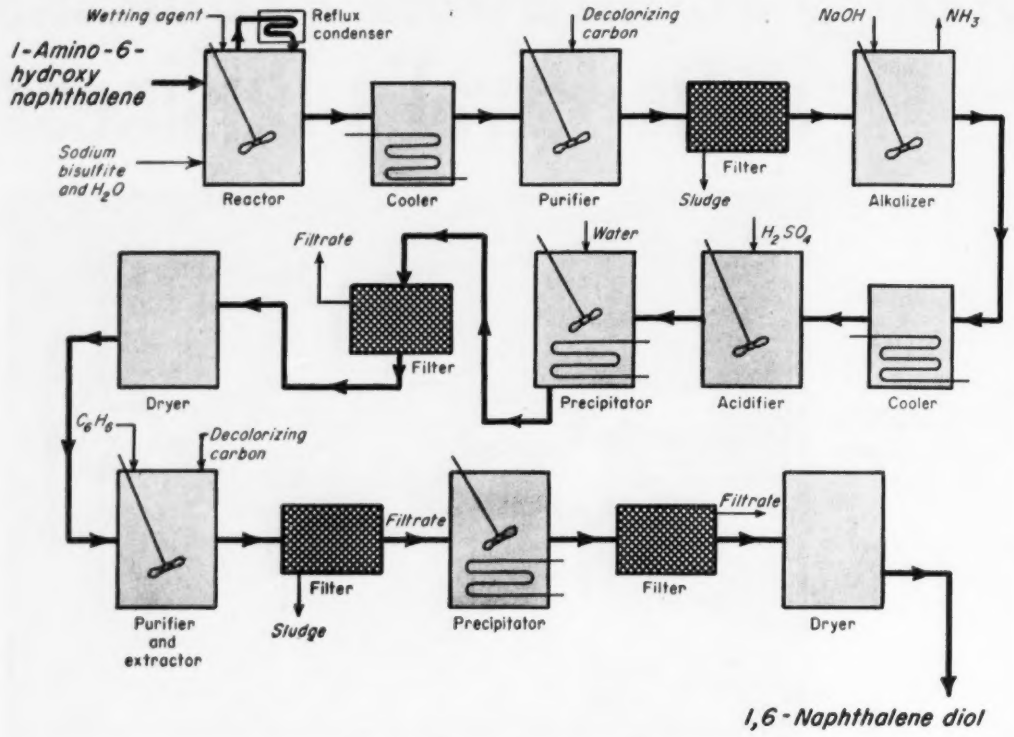

New Preparation of Intermediate a Boon to Steroid Production

Synthetic steroid hormone production is likely to get a boost from the simple and economical preparation of a key starting material, 1,6-naphthalenediol.

The basic three-step process consists of (1) heating 1-amino-6-hydroxynaphthalene with an aqueous solution of a water-soluble inorganic bisulfite, (2) subjecting the reaction mixture to alkaline hydrolysis and (3) acidifying the alkaline solution. The diol is precipitated by cooling (and salting, whenever necessary) the acidified solution.

Crude product is recrystallized from hot benzene—in the presence of decolorizing carbon. Inorganic salts are filtered off. Cooled filtrate yields—in good quantity—a product of excellent purity. The white crystalline diol has a melting point of 137-138 deg. C.

George F. Lisk, the inventor, has assigned his patent, U. S. 2,665,313 to Allied Chemical & Dye Corp.

New Twist In Shale Oil Recovery

Something new's been added to the hundred-and-one retorting schemes for shale oil recovery—water digestion of the shale.

Conventional practices rely solely on heat treatment of shale at high temperatures and pressures. The new process involves a prolonged digestion (about 6 hr.) of lump shale with equal amounts of water at pressures up to 3,000 psi. and temperatures to 700 deg. F.

Water treatment reduces the shale to a soft clay consistency. Kerogen (bituminous material in shale) is dissolved and replaced by water.

Crushed shale sizes of 1 to 2 inches have been successfully processed by this new procedure—with digestion periods not exceeding about six hours.

The inventors, James K. Truitt and George B. Arnold, have assigned their patent, U.S. 2,665,238 to The Texas Co.

This department is designed to keep you up-to-date on what's new in American equipment and processing. It is a digest of recently issued patents, selected and evaluated for you by Dr. Melvin Nord, Chemical Engineer and Patent Attorney, 664 Putnam, Detroit 1, Mich.

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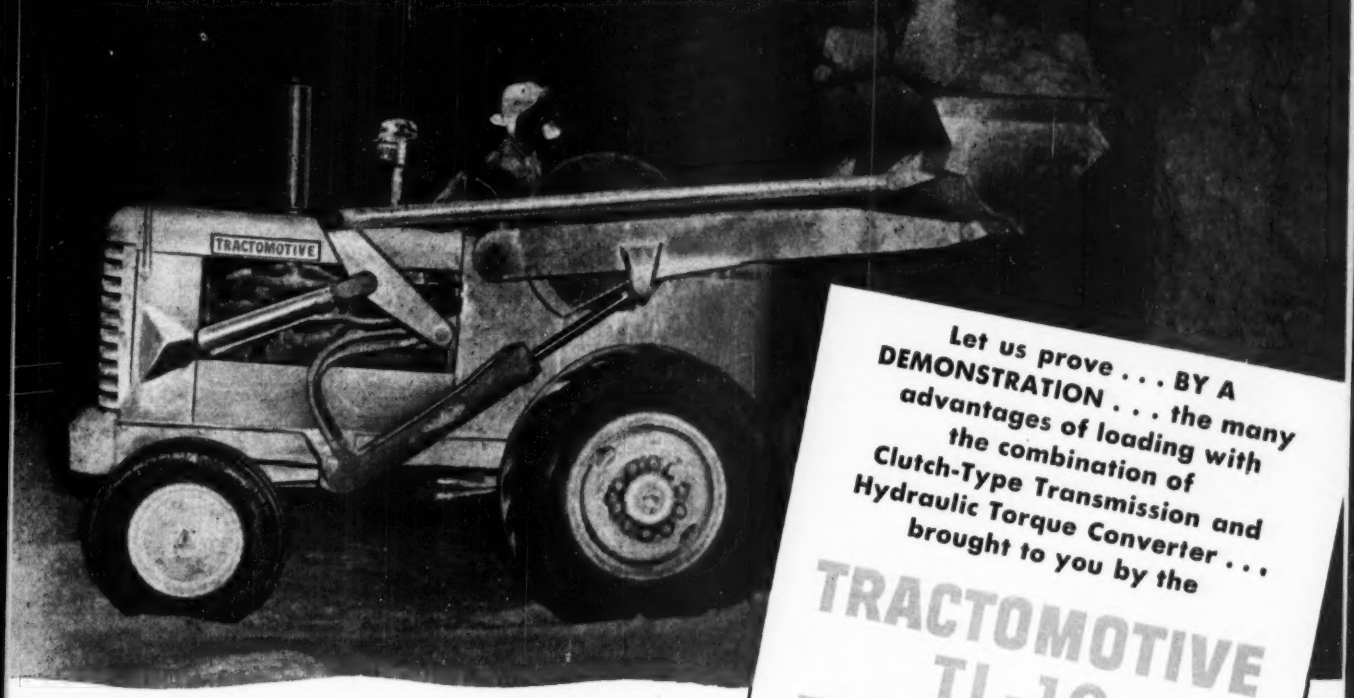


Let us prove . . . BY A DEMONSTRATION . . . the many advantages of loading with the combination of Clutch-Type Transmission and Hydraulic Torque Converter . . . brought to you by the

TRACTOMOTIVE TL-10 TRACTOLOADER

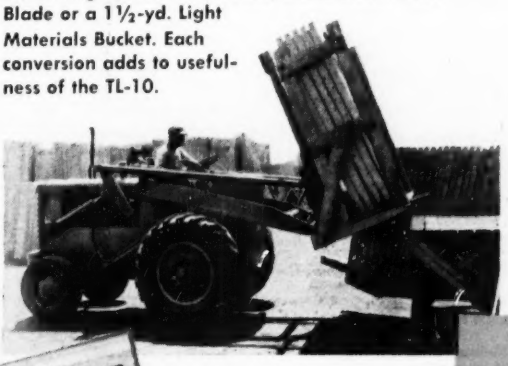
SEE how the smooth-operating HYDRAULIC TORQUE CONVERTER DRIVE speeds loading — no butting or ramming, no engine stalling. No clutching either — operator crowds steadily into pile using only the foot throttle and bucket control levers. Wheel spin is practically eliminated, tire wear greatly reduced. Bucket action is snappy at all times because speed of engine and hydraulic pump remain constant.

SEE how the specially designed CLUTCH-TYPE TRANSMISSION eliminates most shifting. You simply push a lever to go forward, pull it back for reverse. Reverse is almost twice as fast as forward.

SEE how easy it is to maneuver the TL-10. Bucket over drive wheels utilizes weight of load for greater traction...eases weight on rear steering wheels. Turning radius is only 11 ft. at tip of bucket . . . works in areas that would normally accommodate only lower capacity machines. You can turn from a 9-ft. aisle into a 10-ft. bin!

Only by watching the TL-10 work can you fully realize the great savings you can make on bulk material handling. Let us arrange a demonstration NOW! Wire, write or call.

Added Versatility Standard bucket is quickly interchangeable with Lift Fork, Crane Hook, Dozer Blade or a 1½-yd. Light Materials Bucket. Each conversion adds to usefulness of the TL-10.



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Never-Anywhere— A WHEEL LOADER LIKE THIS!

¾ cu. yd. bucket — weight 11,400 lb. — 63 brake hp. Has dynamic, new Allis-Chalmers POWER-CRATER engine . . . gives you high-octane performance on regular gasoline.

POWER-CRATER is an Allis-Chalmers trademark.

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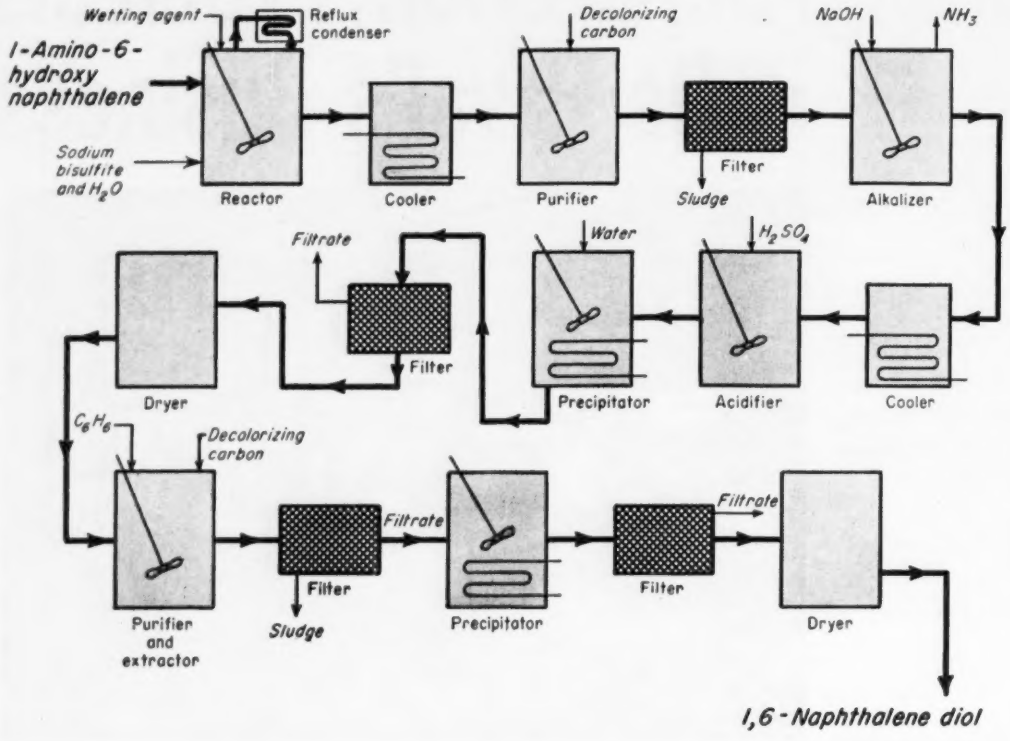
TRACTOMOTIVE CORPORATION, DEERFIELD, ILLINOIS

Tracto-Loaders • Tracto-Shovels, Side Booms and Hydraulic Rippers for Allis-Chalmers Crawler Tractors • Loader and Shoulder Maintainer for Allis-Chalmers "D" Motor Grader



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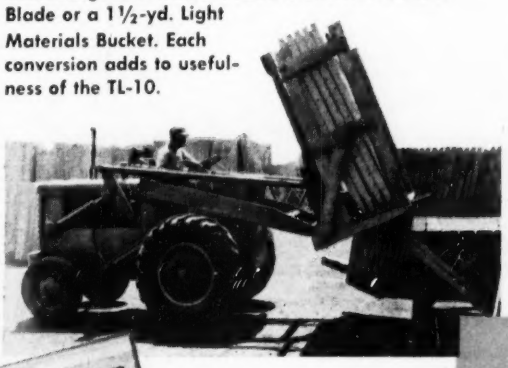

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Your Checklist of New Equipment Patents

Operation . . .	About . . .	Inventor or Assignee . . .	Patent No . . .
Chemical reaction	Electrolytic apparatus for production of metal hydroxides	Paul S. Roller	2,667,454
	Fluidized bed kiln for calcining and similar processes	Norman V. S. Knibbs	2,668,005
	Multireactor pebble heater	Phillips Petroleum Co.	2,671,122
Crushing and grinding	Explosive pulverization of coal	The M. W. Kellogg Co.	2,668,669
	Hammer mill screen-changing mechanism	Nickle Engineering	2,669,396
Extrusion and molding	Means for treating inner surface of plastic tubing during extrusion	W. J. Johnson, L. Danenberg and A. Danenberg	2,668,323–4
	Injection molder	Miller Electric Co	2,668,325
	Molding apparatus	Western Electric Co., Inc.	2,668,985
Filtration	Adjustable filter scraper blade	Goslin-Birmingham Mfg. Co.	2,669,360
	Centrifugal filter	Russell P. Dunmire	2,670,849
Fluid and particle flow	Plug-type control valve for fluidized beds	The M. W. Kellogg Co.	2,668,755
	Pebble feeder	Phillips Petroleum Co.	2,669,506
Gas-liquid separation	Apparatus for removing gases from a liquid	Imperial Chemical Industries Ltd.	2,668,598
Heat transfer	Radiant heater for hydrocarbons	The Lummus Co	2,667,449
	Refrigerator using two volatile liquid refrigerants which are separable by fractionation	Hudson Engineering Co.	2,667,764
	Apparatus for condensing vapors	E. I. du Pont de Nemours & Co.	2,668,424
Instrumentation	Apparatus for determining densities of finely divided solids in a fluidized body	Standard Oil Development Co	2,668,365
	Viscosimeter	Wesley M. Peterson	2,668,441
	Apparatus for indicating and regulating viscosity	Alan Osbourne	2,668,442
Mixing	Continuous mixer	Armstrong Cork Co.	2,668,693
	Agitator	Colgate-Palmolive-Peet Co	2,668,694
	Drum mixer with power-operated discharge positioning device	Kwik-Mix Co.	2,668,695
	Liquid mixer	California Research Corp	2,669,438
	Combination mixer and kneader	Farbenfabriken Bayer A. G.	2,670,188
Solid-gas separation	Dust collector hood construction	Robert Jaron	2,667,017
	Shaker for dust collector filter bags	Walter O. Vedder	2,667,233
	Electrified centrifugal gas cleaner	Research Corp.	2,667,942
	Heavy cyclical centrifuge	The Western States Machine Co	2,667,974
	Separation of finely divided solids from gaseous suspensions	The M. W. Kellogg Co.	2,671,102
Solid-liquid separation	Multiple hydrocyclone	Stamicarbon N. V.	2,668,620
	Clarification of liquid-carrying solids	The Dorr Co.	2,669,357
	Sediment raker for longitudinal settling tanks	The Dorr Co.	2,670,080
	Centrifuge with interstage washing	Knowles Associates	2,670,131
	Centrifugal dewatering machine	Frank R. Wassberg	2,670,850
Solid-solid separation	Sink-float separation	Nelson L. Davis	2,670,078
	Magnetic separation purifies fluids in settling tank	U. S. Hoffman Machinery Corp	2,670,847
Storage	Spherical segment tank	Chicago Bridge & Iron Co.	2,668,634
	Floating roof	Graver Tank & Mfg. Co., Inc.	2,669,371–2
	Storage tank for vaporizable liquids	Hammond Iron Works	2,670,100

. . . And New Process Patents

Product . . .	Process .	Inventor or Assignee . . .	Patent No . . .
Carbon black	Recovering carbon black from a gaseous suspension	Columbian Carbon Co.	2,668,754
Catalysts	Regeneration of iron hydrocarbon synthesis catalyst	Standard Oil Development Co.	2,670,364
Edible products	Purification and stabilization of fruit juices by ion exchange	G. Delmousee, G. V. Austerweil, G. Lemoussu, J. C. Poupinel	2,667,417
	Preparation of dehydrated foods	The Best Foods, Inc.	2,667,419
Fats and oils	Alcoholysis of lower fatty acid groups in poly-hydroxy fatty esters	Kessler Chemical Co., Inc.	2,669,572
	Bodying catalysts for drying oils	Pittsburgh Plate Glass Co.	2,669,573
	Refining vegetable oils in miscella	Canadian Breweries Ltd	2,670,362
Inorganic chemicals	Liquid sulfur recovery from H_2S-containing gases	Jefferson Lake Sulphur Co.	2,665,974
	Production of sodium bicarbonate	Mathieson Chemical Corp.	2,666,686
	Manufacture of crystalline ammonium sulfite monohydrate	Union Oil Co. of Calif	2,666,687
	Production of monoamin boron trifluoride	Frank J. Sowa	2,667,403
	Manufacture of alumina particles	Universal Oil Products Co.	2,667,404
Organic chemicals	Preparation of alkyl mercaptans	Standard Oil Development Co.	2,667,515
	Preparation of chloromethyl methyl ether	The Dow Chemical Co.	2,667,516
	Manufacture of trifluorochloroethylene	The M. W. Kellogg Co.	2,667,518
	Production of alcohols	Standard Oil Development Co.	2,668,181
	Preparation of polyunsaturated fluoro-olefins	William T. Miller	2,668,182
	Production of carbon disulfide	Food Machinery & Chemical Corp.	2,668,752
	Extractive distillation separates acetone from aldehydes and alcohols	Standard Oil Development Co.	2,669,541
	Ion exchange process for protein separation	Allen F. Reid	2,669,550
Rubber	Synthetic rubber from emulsion polymerization of vinylidene cpds.	Phillips Petroleum Co.	2,665,269
	Preservation of butadiene copolymers	Monsanto Chemical Co.	2,668,161
	Vulcanising polychloroprene	E. I. du Pont de Nemours & Co.	2,670,342
Synthesis gas and products	Gasifying carbonaceous solids	Texaco Development Corp.	2,669,509
	Alcohol synthesis	Standard Oil Development Co.	2,669,589
	Hydrocarbon synthesis process	Standard Oil Development Co	2,670,365

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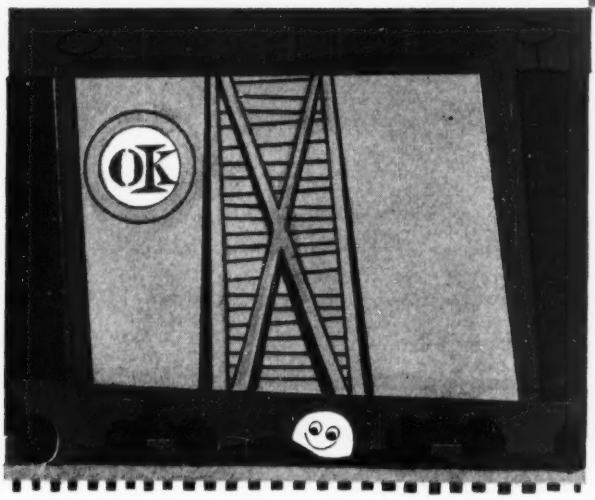

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Backed by over 50 years of experience in electrochemical refining, Norton brings you basic materials whose purity and properties are carefully controlled and consistently duplicated.

These Norton electric furnace products differ greatly in composition and characteristics. They are the source of the many Norton *engineered prescriptions* which have proved of immense practical value in widely varying processes.

Moreover, each of them has possibilities for use which are still undiscovered. It will pay you, therefore, to read the following descriptions very carefully. Even this partial list may contain the exact combinations of properties *you* need.

ALUMINUM OXIDE (ALUNDUM*)

Norton is the world's largest producer of this basic material — fused alumina. *Characteristics:* high melting point, about 3700°F; specific gravity, 3.95; good chemical stability, neutral to most chemical reagents; extreme hardness of 2000 Knoop, with great toughness; reasonably high thermal conductivity, 2½ times that of fire clay; high dielectric strength. *Uses:* heavy refractory furnace shapes; pure oxide and sintered refractories; radio tube insulation; porous media for filtration and diffusion; catalyst carriers and fluid catalysts; heat exchange pebbles; wear-resistant parts; laboratory ware.

SILICON CARBIDE (CRYSTOLON*)

Silicon carbide is produced by Norton in large tonnages. *Characteristics:* high melting point, disassociates at about 4175°F; specific gravity, 3.20; extreme hardness of 2500 Knoop, with excellent abrasion and erosion resistance; high thermal conductivity, 7 to 10 times that of fire clay; excellent resistance to thermal shock; maintains great strength to very high temperatures (PCE, 3350°F — cone 37 to 40); unique electrical qualities; relatively low thermal expansion; no inversion on heating; chemically acidic, with good stability. *Uses:* special refractories for boiler furnaces, ceramic kiln furniture, heat treating, hearth plates, high thermal conductivity muffles and retorts; electrical heating elements; lightning arrestors; metallurgical additions; also available in a Norton-patented process for coating graphite — in rocket nozzles and reaction motor parts, etc. — for increased resistance to erosion by high velocity gases.

MAGNESIUM OXIDE (MAGNORITE*)

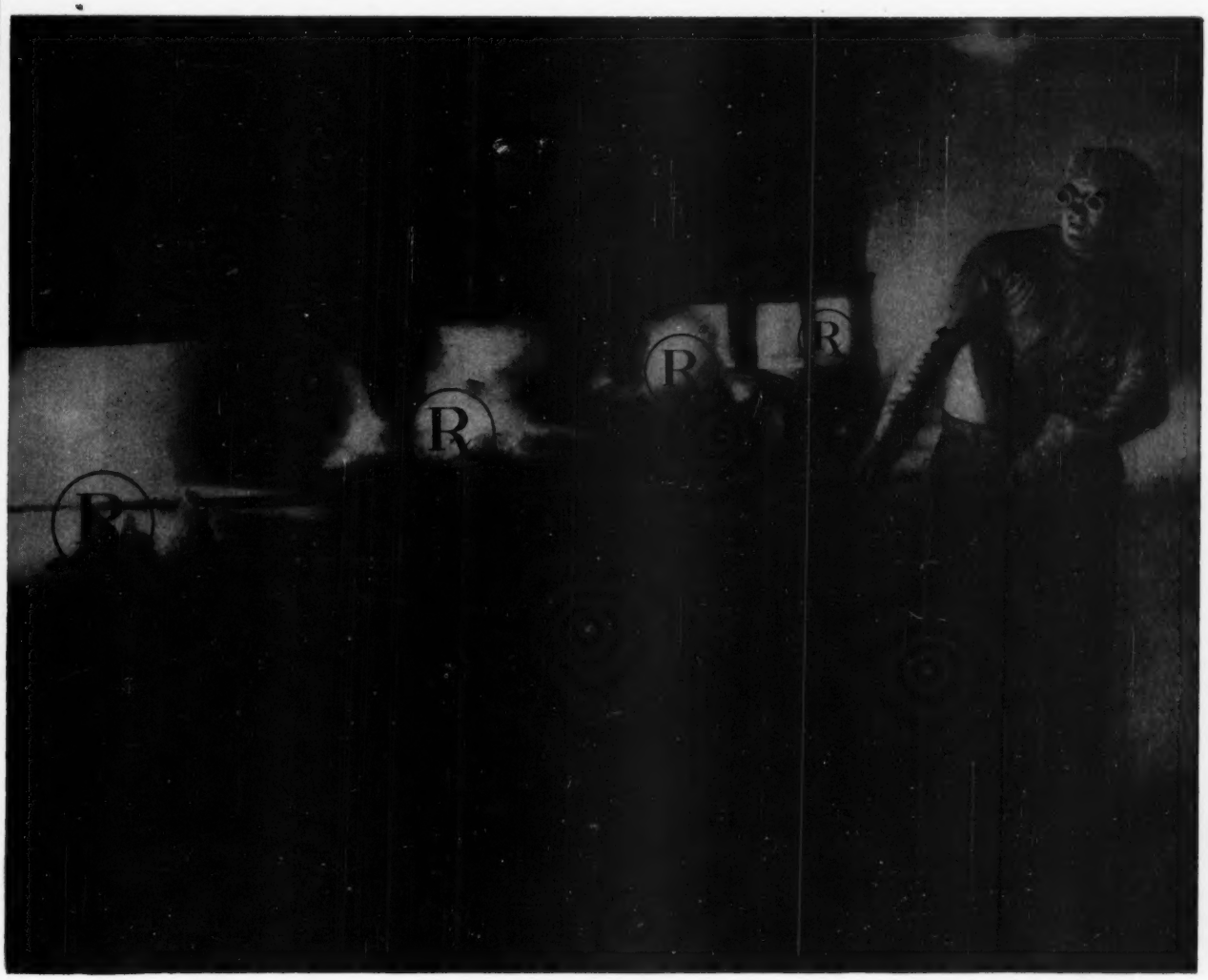
Fused magnesia of highest purity. *Characteristics:* extremely high melting point, about 5,000°F; specific gravity, 3.58; electrical resistivity, 10^8 ohm cm at 1000°C; chemically basic. *Uses:* linings for metal melting furnaces; high temperature electrical insulation; refractories for handling corrosive caustic materials.

FUSED STABILIZED ZIRCONIA

Norton was the first to develop fused zirconia for practical commercial use. *Characteristics:* high melting point; thermal conductivity in British Units at 2000°F is 6.2 for dense shapes, 4.7 for insulating shapes, 2.8 for insulating grain; high resistance to abrasion and thermal shock; not wet by most molten metals; changes from a fairly good electrical insulator at low temperature to a conductor at 1000°C. *Uses:* refractories for extremely high temperatures; setter plates for titanates; furnace linings for high temperature gaseous chemical reactions; zirconium chemicals; metal melting furnace linings; catalyst carriers; heat exchange pebbles; reaction engine parts including jet and rocket liners.

BORON CARBIDE (NORBIDE*)

The hardest man-made material, an exclusive Norton development of boron carbide. *Characteristics:* high melting point, 4440°F; specific gravity, 2.50; compressive strength, 414,000 psi; bending strength, 44,000 psi; self-bonding, unaffected by all acid and alkali solutions. *Uses:* abrasive for economical replacement of diamond dust in lapping; high purity powder of micron sizings for use as refractory and in "cermet" combinations; neutron absorption in nuclear reactors or particle accelerators; pressure-blast nozzles; wearproof bushings, slides, etc.



In these Higgins type arc furnaces tremendous amounts of electrical energy are utilized by Norton in electrochemically refining crude minerals into basic Rx refractory materials.

BORON NITRIDE

Refined by Norton to over 98% purity. *Characteristics:* melts or dissociates at 5400°F; a nonconductor of electricity; weighs only 7 lbs. per cu. ft.; is not oxidized in air at 1200°F. *Uses:* anti-sticking agent for use with molten glass or metal; heat-resistant lubricant; thermal insulator in vacuum or atmosphere furnaces; experimental refractory or crucible material; experimental electrical insulator.

MANY OTHER MATERIALS

Among the high-melting, useful materials made available by Norton are Special Fused Oxides, Refractory Carbides, Refractory Borides, Mixed Borides, Elemental Boron. Research, development and field testing are being conducted on Experimental Borides, Carbides, Nitrides and Silicides. Some of these are in regular industrial use and new uses are being found for others.

AVAILABLE IN MANY STANDARD OR SPECIAL FORMS

Besides supplying these materials in their crude form, more or less as they come from the furnace, Norton has extensive facilities for processing and fabricating — and is ready to work with you in engineering any of these materials to your particular requirements.

GET THIS BASIC MATERIALS BOOKLET

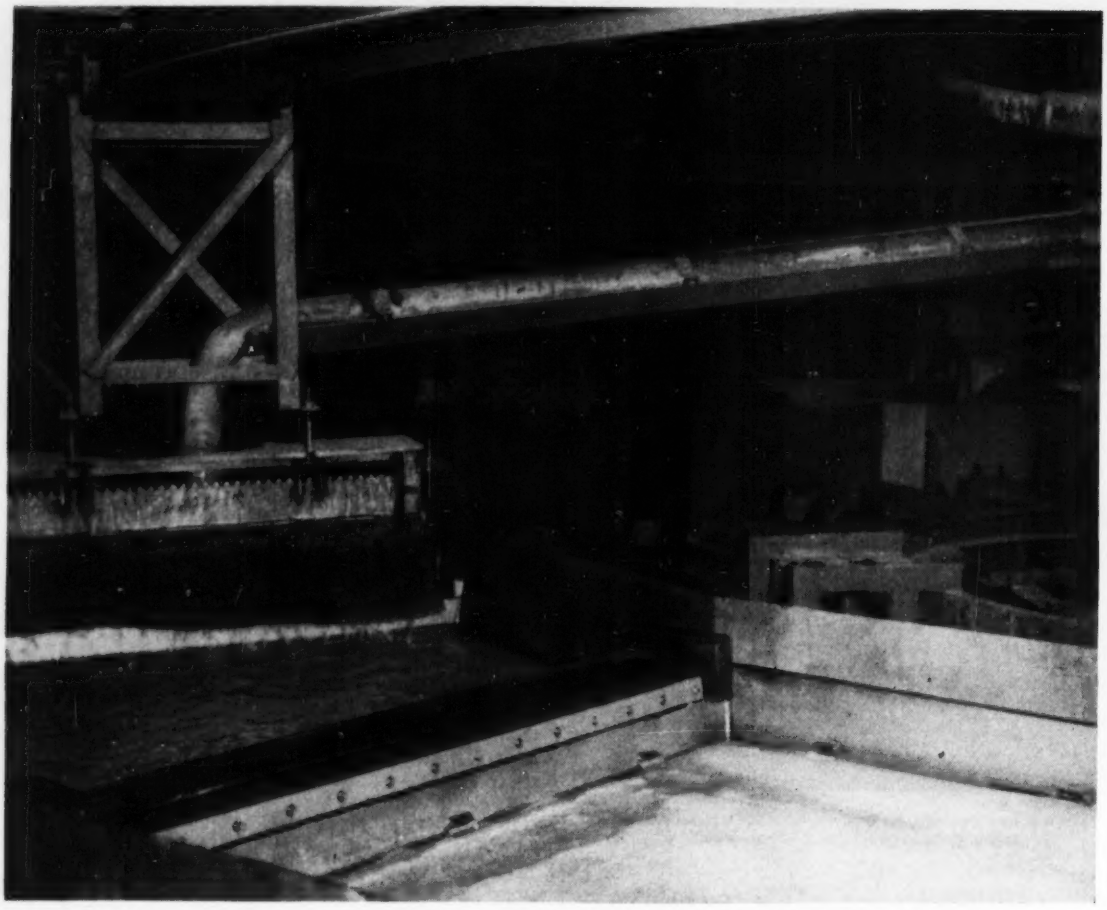
This new Norton Publication, "Basic Materials," contains 22 pages of detailed information, including actual and suggested uses. For your copy, write to NORTON COMPANY, 511 New Bond St., Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

NORTON
Rx REFRACTORIES

Making better products . . . to make other products better

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

NEW PROCESSING EQUIPMENT



SEGREGATION of wash liquor on individual filtering elements avoids intermingling between stages to give . . .

Better Washing on New Turntable Filter

Merry-go-round filter uses less water to purge filter cake of residual liquor. Filtrate is stronger, concentrating costs are reduced or eliminated.

Here, at last, is a continuous industrial filter design that duplicates the action of a Buechner funnel. It enables the Prayon filter completely to separate wash liquors from mother liquor and between countercurrent stages. That means more thorough cake washing using less wash water.

▶ **Wash Water Halved**—It's possible to purge residual liquor from the filter cake using no more than one theoretical displacement. On filtration jobs producing valuable filtrate that's a solid saving.

Normal performance with conventional filters requires two displacements, i. e. volume of wash water is twice that of residual liquor in cake. By halving water introduced to the Prayon filter system, a stronger filtrate is discharged. Further concentration no longer may be needed to satisfy subsequent process or end-use requirements.

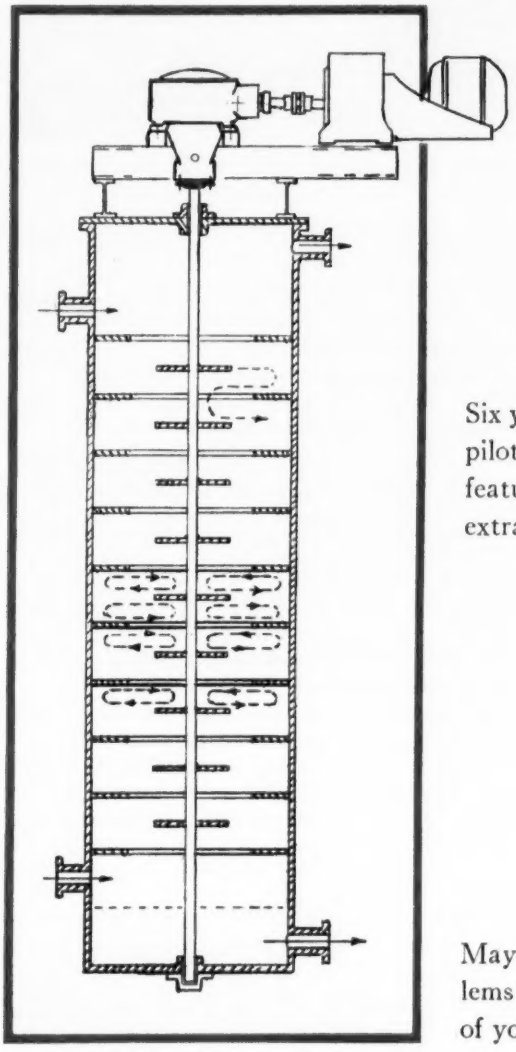
Although newly introduced to the United States by Singmaster and Breyer, New York, this newest addi-

Turbo-Topics

TURBO-MIXER GENERAL AMERICAN TRADE MARK

TURBO-MIXER, a division of

GENERAL AMERICAN TRANSPORTATION CORPORATION



Turbo-Mixer R.D.C.* Column

Rotary Disc Contactor for Liquid-Liquid Counter-current Extraction

Six years of data and design development in the laboratory, pilot plants and industry have demonstrated the superior features of this practical counter-current and gravity flow extractor. The R. D. C. extractor offers:

1. **high volumetric efficiency**
2. **high throughput capacity**
3. **simplicity of construction**
4. **no interstage or external settlers**
5. **low power requirements**
6. **flexibility of operation**

May we assist you in the solution of your extractor problems? Our laboratory facilities are available for evaluation of your extraction system.

**Licensed under Shell Development Company patent*

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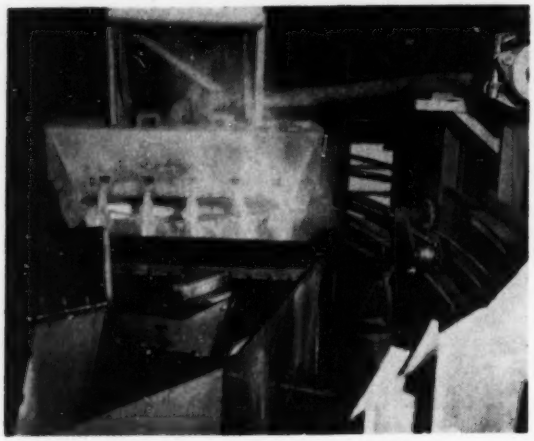
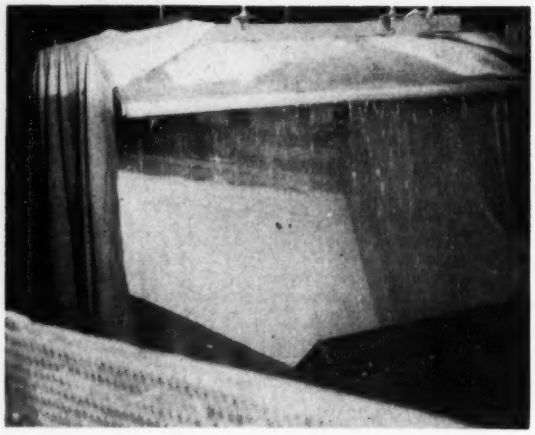
OTHER GENERAL AMERICAN EQUIPMENT:—DRYERS • EVAPORATORS DEWATERERS • TOWERS • TANKS • PRESSURE VESSELS

Entering and Leaving New Prayon Filter



FEED is distributed evenly across filter cell surface.



DISCHARGE is done by tipping and dumping over chute.

tion to this group of filters is no rookie in big time operations. Claims of superior performance are backed by on-stream operating data, both here and abroad.

▶ **Young Veteran**—Prayon filters now handle gypsum filtration (see p. 128) for an aggregate phosphoric acid production equivalent to 900 tons P_2O_5 per day. And the filter is well launched on another process where large tonnages of ore leach-residue must be filtered and washed, effecting maximum recovery of solubles with minimum or no dilution of the strong liquor.

▶ **Big Wheel** – Picture a wheel mounted horizontally with Buechner funnels all around the rim. Add a few essential refinements and you have a Prayon vacuum filter.

Individual filtering element, analagous to Buechner, is called a cell. It's approximately rectangular, has molded rubber drainage grid supporting suitable filter fabric. And like a Buechner, or a cup, it has sides.

A number of these cells are supported in close order around the periphery of a rotating, horizontal, wheel-like frame. Flexible hose connects each cell to a central valve located at the hub of the wheel.

As frame rotates, cells pass under feed trough that introduces feed slurry across full width of cell. After traveling a short distance around the circle to permit dewatering, cell passes under water distributor at first wash station.

▶ **Washes Segregated**—Wash liquor is applied by spreader to give even distribution. Sidewalls of cell prevent any mingling of wash liquors between adjacent cells. Thus washing is truly countercurrent; up to five stages are possible.

Entering the discharge section, following the last wash stage, the cell is tilted gradually. As it rotates, any remaining liquor in the drainage section drains to the low corner to be sucked away through vacuum connection.

Before tilting stops, cell has rotated a full 180 deg. over cake discharge hopper. Blowback air loosens the cake to help it fall free. Once clear of the discharge chute the cell is sprayed with wash water, flopped right side up and sucked dry. Then it's ready for the next round of filtration and washing.

▶ **Pouf, No Wear**—It's said this method of discharge, again like the laboratory Buechner, is complete and trouble-free. No heel is left on the cloth. Absence of mechanical wear means long cloth life; washing after discharge keeps cloth uniformly open and filtration rate high.

Another point—if cloth on a cell needs replacing it can be done within minutes. Loosen a few dogs, lift a bar frame out of recessed slots and the cloth is freed. A complete change of filter cloth on the largest filter takes only 3 hr.

Prayon filters are being offered in the following sizes: 16, 107, 183, 290 and 516 sq. ft. **296A**

Filter Plate

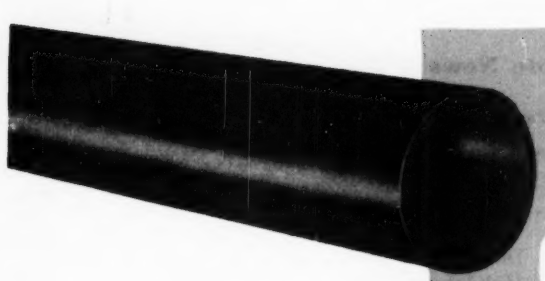
Is lighter weight and easier to handle, yet adequately strong.

Increased over-all efficiency of filter press operation is claimed through use of the Multi-Plate. This fabricated unit for plate and frame filter presses is lighter than the usual cast plate construction. Then, too, it is easier to clean and maintain.

A corrugated sheet-metal drainage shield of stainless steel or other selected metal is supported and welded in a rugged channel frame or a solid rim. Resultant plate has much greater structural strength than required to withstand maximum filtration pressure.

Multi-Plate is considerably lighter than cast plate, hence is much easier to handle. Weight of Multi-Plate is approximately 1/6 to $\frac{1}{8}$ that of conventional cast filter plates in the size range from 12 to 48 in.

This fabricated filter plate can be used in any conventional filter presses. It is available also in recessed plate design.—**Multi-Metal Wire Cloth Co., Inc., 1350 Garrison Ave., New York 59, N. Y.** **298A**



for HOT corrosives

ace tempron

New HIGH HEAT RESISTANT HARD RUBBER

pipe · fittings · chemical parts

Ace Tempron . . . a new synthetic hard rubber for chemical equipment—now offers unexcelled chemical resistance *plus* economy for high temperature applications. In your plant, Tempron can handle many corrosive liquids—*hot*—at costs below other materials you've had to use up to now.

Based on nitrile synthetic rubber (Buna-N), Tempron is *hard* rubber—with better temperature and chemical resistance than hard or soft nitrile rubber compounds hitherto available. Mechanically it withstands temperatures up to 225 deg. F. and higher. Chemically it resists most inorganic chemicals and many organic chemicals and oils at temperatures to 200 deg. F.—and far higher in specific instances. At room temperature it has better resistance to some of the organic chemicals than other rubber and plastic materials.

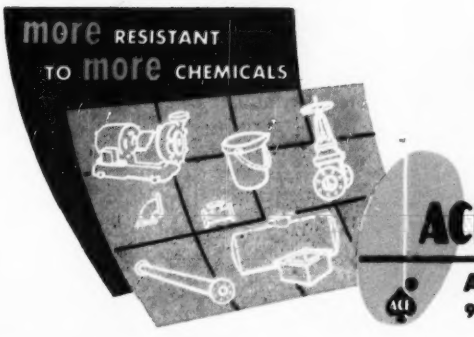
In one case, Tempron pipe is still in excellent condition after 2 years on hot brine, far exceeding the life of the steel pipe it replaced.

We're now ready with Tempron pipe in 1", 1½", 2", 3" and 4" sizes and fittings in 2", 3" and 4" sizes. Additional smaller sizes of pipe and fittings are under development. We can also—now—produce molded parts, and sheets, rods and tubes from which we (or you) can fabricate a wide variety of parts.

Write today for new bulletin No. 96-A giving full details of Tempron. Or ask for samples and recommendations for your specific applications.

ACE TEMPRON resists:

TESTED AT 200 deg. F.	Hydrochloric Acid, 38% Sulphuric Acid, 50% Phosphoric Acid, 85%	Sodium Hydroxide, 20% Sodium Chloride Ethylene Glycol	Formaldehyde Kerosene Ferric Chloride Stannous Chloride
TESTED AT 78 deg. F.	Benzaldehyde Aniline Pyridine Gasoline	Ethyl Acetate Benzene Toluene Carbon Tetrachloride	Ethylene Dichloride Chlorobenzene Carbon Disulfide Nitrobenzene



ACE rubber and plastic products

AMERICAN HARD RUBBER COMPANY

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Equipment on These Pages This Month Made News . . .

Page Number is also Reader Service Code Number

New Processing Equipment

Turntable Filter 296A
Filter Plate 298A
Surface Filters 300A
Blender 300B

New Instruments & Controls

Computer Component 302A
Signal Transmitter 302B
Recorder Controller 302C
Vacuum Controller 302D
Industrial pH Meter 302E
Instrument Valve 304A
Speed Control 304B
Pressure Transmitter 304C
Flow Regulator 304D
Gas Analyzer 304E

New Heating & Cooling Equipment

Fin Tubing 306A
Steam Trap 306B
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New Fluids Handling Equipment

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Vacuum Pump 308C
Dust Collector 308D
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New Electrical & Mechanical Equipment

Speed Reducer 312A
Variable Speed Drive 312B
Glass Working Lathe 312C
Cup Packing 312D
Teflon Seal Cage 312E
Variable Pitch Sheave 312F

New Packaging & Handling Equipment

Mixing Unit 314A
Bulk Unloader 314B
Pouring Rig 314C
Unloading Conveyor 314D
Production Scales 314E

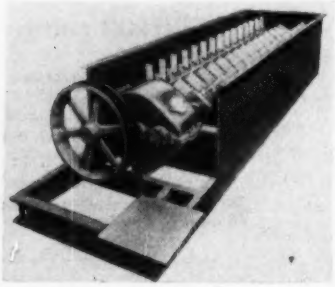
. . . For more details, use Reader Service Card on page 525

Multiple Surface Filters

With porous metallic medium now made in large capacity sizes.

This stainless steel container 12 in. in diameter by 20 in. high houses 30 sq. ft. of filter area. Similar units are available with filter areas up to 720 sq. ft., and cake space capacity up to 35 cu. ft. They are recommended for clarification and solids collection, handling such diverse fluids as water, petroleum products, and molten metals.

Filter medium is high-temperature-resistant porous stainless steel. Container may be either carbon steel or stainless steel, as required. Compact design permits steam jacketing and construction for high-pressure and sanitary requirements.—**Micro Metallic Corp., Glen Cove, N. Y.** **300A**



Blender

Mixes fine solids and liquids.

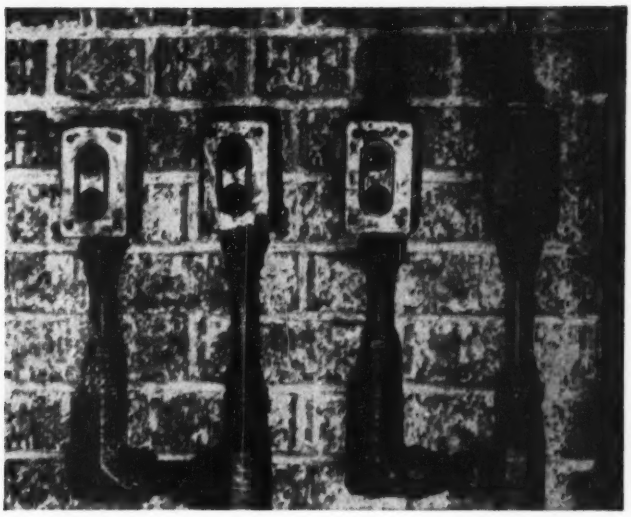
Originally, the Hydro Blender was designed for blending water and iron pyrites used in producing SO_2 gas. Now, it's available for other operations requiring the blending of fine solid materials with liquids.

The Hydro-Blender is essentially a long steel box-like unit having two 12-ft. long paddle shafts which revolve in opposite directions. As the paddles mesh at the center, materials are blended and moved ahead. Finished material discharges from the drive end through a spout.

Two sizes of Hydro-Blenders are available; one size having 6-in. square by 12-ft. paddle shafts and the other 8 in. square by 12-ft. shafts. A row of paddle bases are welded to each face of the shaft with renewable abrasion resistant paddles bolted to the bases.—**McLanahan & Stone Corp., Hollidaysburg, Pa.** **300B**

For More Information . . .

about any item in this department, circle its code number on the Reader Service Postcard inside the back cover.



Here's proof... Republic Dekoron-Coated E.M.T. resists hydrochloric acid atmosphere

The raceway and switchgear shown above get a 24-hour-a-day drenching in hydrochloric acid fumes at Huron Milling Company's plant in Harbor Beach, Michigan.

Within a six-month period, the switchgear was replaced twice. After 15 months, Republic "Dekoron-Coated" Electrical Metallic Tubing had not changed physically.

This is only one of the extra-tough operating conditions in which "Dekoron-Coated" raceways stand up. And one reason is the fact that this corrosion-resistant raceway gives double protection. It's a plastic armor of polyethylene extruded over the zinc-coated steel to protect the raceway. Fittings and joints in the raceway are easily protected with plastic or vinyl tape. Runs are protected from end to end.

The result: raceways that stay on the job longer in tough locations, are easy to install, and cost less because they last longer. This "Dekoron" coating is available on both E.M.T. and Rigid Steel Conduit. Booklet DEK-1 lists the corrosive materials that can't affect it, along with instructions for installations. Write for it.

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REPUBLIC STEEL

ELECTRUNITE E.M.T.

LIGHTWEIGHT THREADLESS RIGID STEEL RACEWAY

Computer Component

For analog type in subminiature, has no moving parts, and can be plugged in.

That small cylindrical object on the right, above, replaces the geared assembly on the left which is a basic computer component assembly. It is said to operate five times as fast; can subtract, multiply, divide, integrate, and perform basic operations of vector algebra and vector calculus.

Briefly, this element may be considered as a thinking mechanism in automatic process control which connects the senses with the muscles performing the necessary duties. Thus, to the terminals of its receptacle must come electrical signals from intelligence devices. Out from its terminals go electrical signals either to display mechanisms or to order devices.

The completely new concept behind design of this component eliminates all mechanical movement. Electrical intelligence signals entering the unit are converted to heat. Then after some automatic arithmetic derived from built-in circuitry the resultant heat is reconverted into electrical order signals. Measures to accomplish this without appreciable time lag are the key to its success.—**Arma Corp., Roosevelt Field, Garden City, N. Y.** **302A**

Signal Transmitter

Operates pneumatically with standard instrument for remote metering and control.

A specially designed pneumatic signal transmitter makes the ring balance meter readily adaptable to a wide variety of remote metering and control applications. These include control installations requiring reset, remote adjustable set point and rate action.

Transmitter is actuated by movement of the pen arm or indicator follower of the meter, without introducing any perceptible load on the sensing element. These movements are transmitted to a baffle which moves about a fixed pivot to throttle air discharge from the control nozzle. Sensing element movement is converted, therefore, into a proportional pneumatic signal that follows faithfully any function measured.

Available maximum signal pressure ranges are 15, 30 and 60 psi. Output from the transmitter can be used to actuate receiver-type integrating or recording instruments, or as the actuating signal for an automatic control system.—**Hagan Corp., Pittsburgh 30, Pa.** **302B**

Recorder Controller

Assembled from unit components operates on null-balance principle.

A new line of recorder-controller instruments provides low first cost, low operating and maintenance costs, and maximum flexibility. Instruments are used for recording and controlling temperature, conductivity, strain, force, position, pressure and for telemetering.

Four readily interchangeable units make up the total assembly. Instrument operates on the null-balance principle using a.c. signal actuation. No batteries or standardizing circuits are required.

A range of nickel, tungsten and platinum resistance temperature detectors is available. They cover temperatures from −328 to +932 deg. F. —**Fielden Instrument Div. Robertshaw-Fulton Controls Co., 2920 North Fourth St., Philadelphia 53, 33, Pa.** **302C**

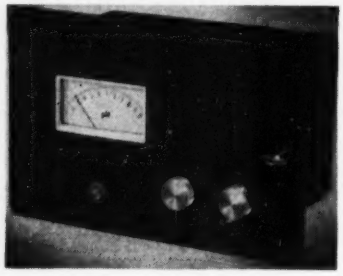
Vacuum Controller

Holds industrial vacuum systems within upper and lower limits.

Industrial vacuum systems can be maintained automatically in any preset range between 1 and 1,000 microns of mercury by a new indicator-controller instrument.

New unit provides upper and lower limit control and automatic reset. After user sets contacts for limits required, instrument provides stable fully automatic means of controlling vacuum at desired level.

Typical industrial application includes controlling vacuum pump to maintain vacuum within given limits. Instrument also may be used to operate alarm when vacuum moves to either upper or lower limit.—**Hastings Instrument Co., Inc., Hampton 11, Va.** **302D**



Industrial pH Meter

For panel mounting can be serviced within minutes.

Use of plug-in circuits enables nonspecialists to repair a new industrial pH meter within minutes. Loosening a few screws does the trick; a spare is quickly installed and the instrument resumes work.

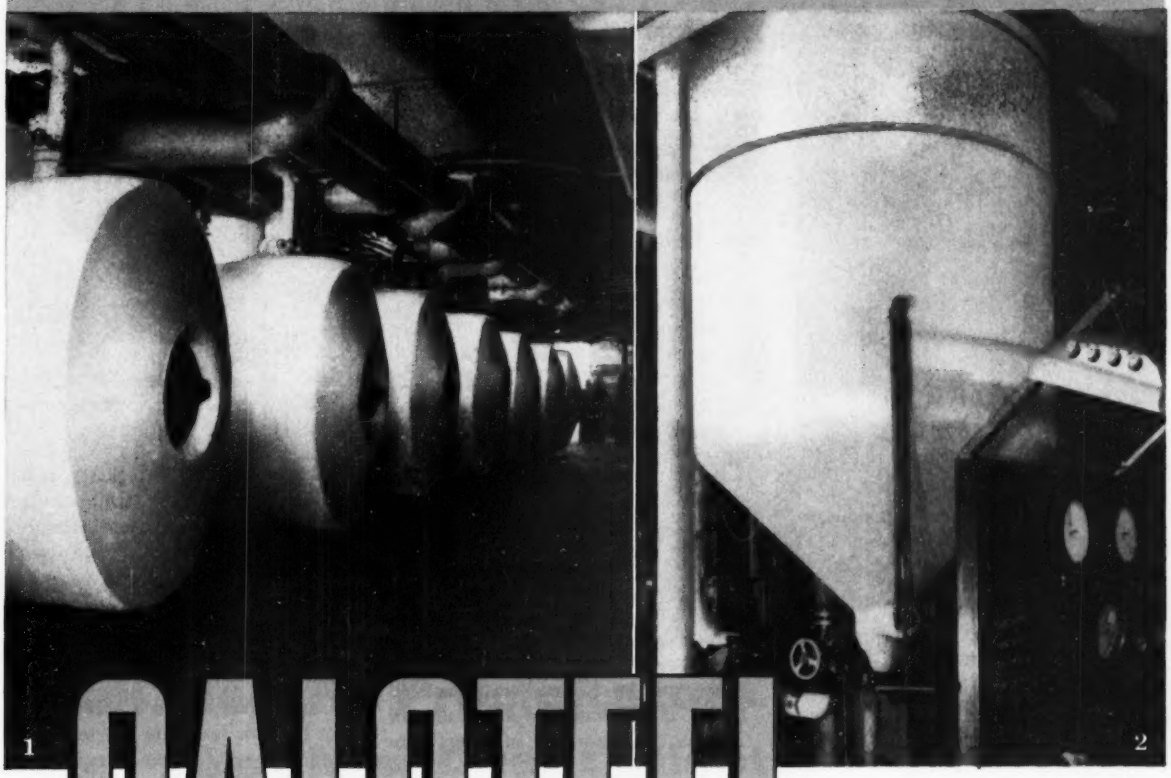
Designed for panel mounting the compact meter accommodates virtually any combination of recorder and meter ranges. Its circuit allows the recorder pH scale to be shifted up or down, expanded or compressed. The entire pH scale or as few as 3 pH units can be recorded full scale on the chart.

Instrument uses standard glass pH electrodes, potentiometric recording and controlling equipment as well as external indication meters.—**Beckman Instrument Inc., South Pasadena, Calif.** **302E**

For More Information . . .

about any item in this department, circle its code number on the Reader Service Postcard inside the back cover.

ANOTHER CALSTEEL FABRICATION JOB!



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2

CALSTEEL

ENGINEERED FABRICATION

CUSTOM INSTALLATIONS FOR BEST FOODS, INC., SAN FRANCISCO

Fabricated and erected by CALSTEEL. *Including (1) a battery of Winterizing Cells with Ammonia Coils; (2) 10' 6" diameter 20% Stainless Clad Cooker; as well as 11' 6" diameter 20% Stainless Clad Deodorizing Kettles.*

The custom-engineered fabrications for this modern plant illustrate again the scope of CALSTEEL services. Whether for the Process, Oil, Gas, Atomic Energy or Power Industries, CALSTEEL fabrication assures precision execution of the most exacting specifications. For *your* fabrication requirements, call on CALSTEEL.

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Process, Oil, Gas
Atomic Energy and
Power Industries

CALIFORNIA STEEL PRODUCTS COMPANY

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PLANTS IN RICHMOND, CALIF. & NORTH TONAWANDA, N. Y.

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Instrument Valve

For high-pressure service is compact and light weight.

This 6,000 psi. Hancock stainless steel instrument valve is small, easy to handle and weighs only 2¼ lb. It is designed for service on instrument panels and lines, gage, by-pass and corrosive lines, and orifice meters.

Space-saving compactness permits close alignment of piping with near structures. Packing gland can be pulled tight readily in close quarters and disassembly presents no problem. Available sizes are ¼, ⅜ and ½ in.—**Manning, Maxwell and Moore, Inc., 65 Grove St., Watertown 72, Mass.** **304A**

Speed Control

Governs rotary speed automatically and precisely.

Engineers faced with problems in controlling rotary speed would do well to investigate the KC-223 mechanical electric translater. This automatic control is available in two models: the first will open or close any desired electric circuit at a predetermined rpm; the other is a multi-speed instrument which can be used for the automatic control of a sequence of operations.

Translater operates in the range from 1,200 to 5,000 rpm. with an accuracy of ±2 percent. It measures only 2½ in. in diameter by 4½ in. high. It operates satisfactorily in any mounting position and can be adjusted to operate at any desired rpm. within the indicated rate.—**Kahn & Co., Inc., 541 Windsor St., Hartford 1, Conn.** **304B**

Pressure Transmitter

For measuring fluids provides positive seal receiver and fluid.

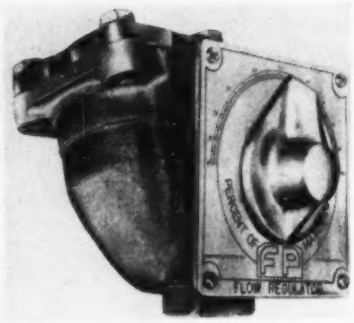
Model 6100F pressure transmitter operates with pneumatic instruments to measure liquid and gas pressure, depth, weight or volume of liquids in vented and pressurized tanks. Transmitter provides a positive seal between the gaging system and the fluid being measured. It can be used with practically any fluid, including many that would be dangerous or difficult to measure otherwise.

Instrument is essentially a one-to-one transmitter and has linear response from one-half inch of water upward. It permits accurate readings at all pressures up to 20 psi. in vented tanks and to 45 psi. in pressurized tanks. It withstands over-pressures of 250 psi. Air consumption is less than 2 cfh.

Pressure transmitter includes a snubber, a diaphragm, and a venting orifice. The fluid being measured contacts one side of the diaphragm. Clean air on the other side of the diaphragm is regulated automatically to a pressure that just balances that of the fluid being measured. This pressure is transmitted to a receiver.

Air at a controlled rate enters the transmitter through a supply line and is exhausted to atmosphere through the venting orifice and air vent. When fluid pressure increases, the diaphragm momentarily moves closer to the venting orifice. This restricts outflow of air. Air continues to enter the transmitter through the snubber, so that pressure inside the diaphragm builds up quickly. As soon as it balances fluid pressure the diaphragm returns to equilibrium position, opening the venting orifice and preventing any further buildup of air pressure.

Conversely, when fluid pressure decreases, movement of the diaphragm opens the venting orifice, permitting faster exhaust of the air. In turn, air pressure drops and the diaphragm returns to equilibrium point.—**King Engineering Corp., Box 540, Ann Arbor, Mich.** **304C**



Flow Regulator

Holds preset rate even when pressure varies.

A new low-cost flow regulator maintains a preset flow rate despite changes in upstream or downstream pressures. It offers flow control where costly equipment is not justified.

Controller operates by sensing differential pressure. Constant flow rate is maintained by holding a constant pressure differential.

Unit is available in ½, 1 and 2 in. sizes for flow ranges of 0.5 to 5, 1 to 15, and 6 to 80 gpm., respectively. Reproduceability of flow rate is within ± 3 percent over a pressure drop range of 5 to 125 psi. Regulator is adaptable to in-line or panel mounting.—**Fischer & Porter Co., 17 Jacksonville Rd., Hatboro, Pa.** **304D**

Gas Analyzer

Uses ionization produced by beta radiation to measure gas.

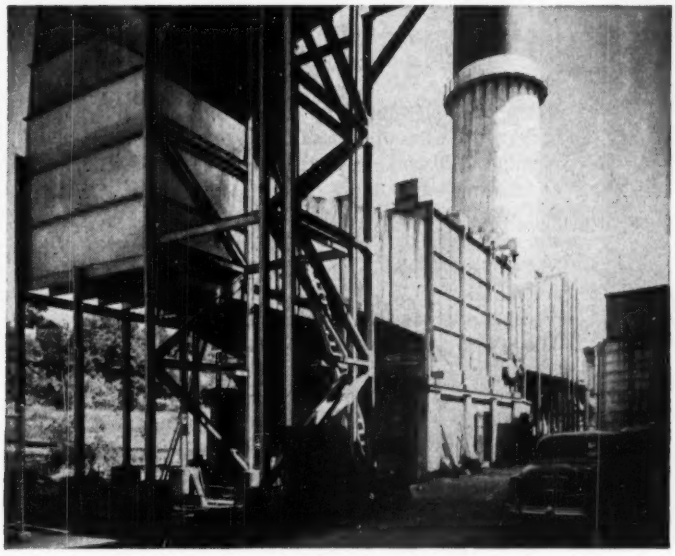
Continuous analysis of binary gas mixtures now is being done using the radio-logical gas analyzer. Instrument uses Strontium 90 as a source of beta radiation.

This material is an abundant and inexpensive fission product. It has a relatively long half life and emits only beta radiation, thus minimizing the shielding problem.

Measurement of the gas depends upon ionization produced in the gas by beta radiation. First installations of this unit have been for measurement of argon in ammonia plant.

Instrument was designed by Shell Development Co. Both standard and explosion-proof models are available.—**Hallikainen Instruments, 1341 Seventh St., Berkeley, Calif.** **304E**

From Pennsylvania *to Peru...*



Buell Electric Precipitators Set New Dust Collection Records!

Work with equal economy and efficiency on wide range of different and complex dust collection problems . . . from foundry dust and cement to minerals from smelting operations.

Drastically cut maintenance costs. Even better, there's less to maintain because of new, simpler design.

Set new efficiency standards far beyond currently accepted levels. The exclusive Buell Spiralectrode is typical of the advances that make this possible.

Work effectively in combination with other Buell equipment. Many such combinations now operating. The Electric Precipitator with one, two or three stage Buell Cyclones, for example.

● It's impossible to tell the whole story here. That takes your examination of the actual performance information now available. We're skeptics ourselves! That's why we want to meet the most skeptical engineer around . . . we believe we can send him away with a smile! Why settle for less than a good, long look? Write Buell Engineering Company, Dept.12-F, 70 Pine Street, New York 5, N. Y.

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MECHANICAL ELECTRICAL *20 Years of Engineered Efficiency in* **DUST COLLECTION SYSTEMS**

Fin Tubing

Now made with integral fins on the internal surface.

Tubing now is being extruded with integral fins on the internal surface. These I.D. fins, as shown in the illustration, are produced in tubing extruded of a special heat-resisting stainless steel. Tubing is being used in a heat exchanger with fire on the outside and gas on the inside.

Production of this specialty has passed the purely experimental stage. Similar tubing can be produced from a number of steels in a limited size range.—**Tubular Products Div., The Babcock & Wilcox Co., Beaver Falls, Pa.** 306A

Steam Trap

Vents air from system at high rate.

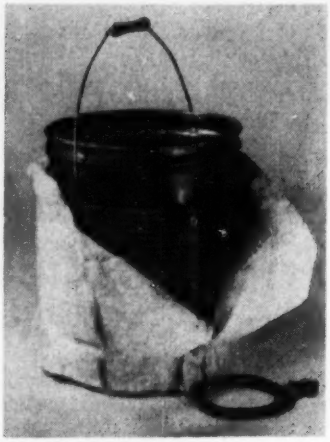
Increased air venting capacity has been built into the Heat-Kwik Super-Silver-top steam trap. On the basis of tests, it is reported to vent air out of steam-consuming units eight times faster than ordinary inverted bucket traps and three times faster than air eliminator or blast type traps. In turn, this means faster heating up, more production, lower steam consumption, and longer trap life.

Rapid air venting is gained through use of two separate orifices; one for condensate and a separate bellows orifice for air.

When the trap is cold the bellows orifice is wide open and handles large quantities of air very rapidly. After all air is removed, the bellows expands and closes the orifice. Thereafter, air leaves throuogh the vent hole in the bucket. Since very little air remains in the system, the vent hole has ample capacity.

Trap can be opened for inspection or servicing without removal from the pipeline. All working parts are made of heat-treated stainless steel. A special chrome-nickel alloy is used on the valve and seat.

Traps are available from ¾ to 1¼ in. suitable for pressures to 150 psi.—**V. D. Anderson Co., Dept. H, 1935 West 96th St., Cleveland 2, Ohio.** 306B



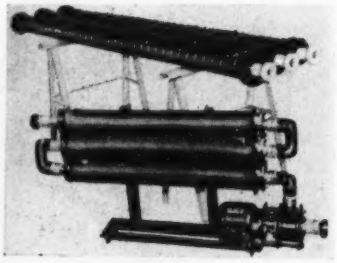
Drum Heater

Supplies heat evenly, bringing drum contents to correct temperature.

Heating is gentle when done by this new electric drum heater. Unit is especially suited to heating substances that are easily damaged by overheating. Heat is applied uniformly around the drum and can be sufficiently gentle so that melting points are not exceeded.

Heaters are constructed of alloy resistance wire. They are covered with suitable insulation for electrical safety and an outer braid for wear resistance. Power is furnished from a 115-v. circuit.

Heater wraps around the drum and is held securely with snap fasteners. A blanket of fibrous glass can be used to surround the heater and drum, thereby increasing speed of heating.—**Pre-Fab Heater Co., Guilford, Conn.** 306C



Heat Exchangers

Using simplified design make low area cost possible on corrosive solutions.

At the top of the picture are three tantalum, jacketed heat exchangers designed for use on chrome plating. Plain end tantalum tubes 1¾ in. I.D. x 9 ft. long x 0.02 in. wall are used in these exchangers.

The lower unit is a standard Karbate pump and exchanger unit now being used for heating and cooling, plating and pickling solutions. Many are also used for controlling temperature in chemical processing.

These units are examples of standard designs now available from stock in most cases. Low cost per sq. ft. is claimed for exchangers fabricated of materials such as tantalum, Karbate, stainless steel, nickel, and black iron.—**Carl Buck & Associates, Essex Fells, N. J.** 306D

Packaged Boiler

Meets maximum rating without pushing or strain.

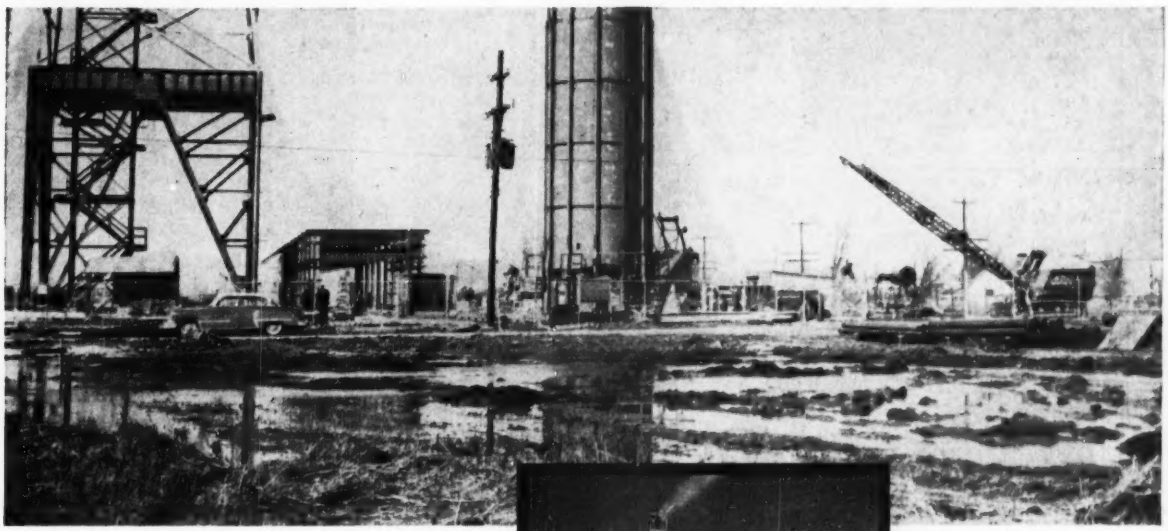
Rated at 125 hp., a new self-contained fully-automatic Scotch marine boiler is designed for industrial heating and processing applications. It develops rated horsepower efficiently under normal operating conditions.

Special features are larger than average steam space, combustion area, water storage area, and heating surface. Tests have shown boiler can produce high heat output without strain or danger of heat cracks. Extra reserve capacity eliminates fluctuations in steam pressure.

Boiler comes completely assembled ready for immediate operation after electricity, steam, water, fuel and stack connections are made.—**Eclipse Fuel Engineering Co., 1002 Buchanan St., Rockford, Ill.** 306E

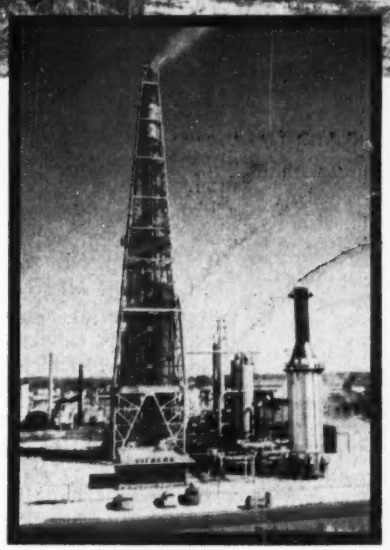
Mud...snow...cold can't slow "package" refinery job

"Bogged" but not "down"— SWECO crews poured foundations, laid pipe lines, conduit, and built structures . . . fighting bad weather and mud all the way. To hold schedule, tons of rock were dumped in the mire to support construction equipment . . . excavations were pumped out day after day . . . straw blankets kept new concrete from freezing. Meanwhile, fabrication of process vessels went ahead in SWECO's own shops.

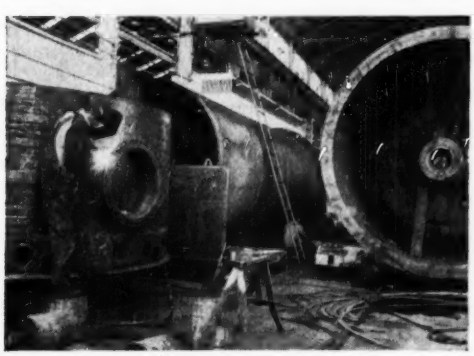


Despite severe winter weather, construction by SWECO of a "packaged" T.C.C. unit for Bay Refinery Company, Bay City, Mich., has proceeded strictly on schedule. Fabrication of all heat-exchangers, fractionators and other vessels was completed in SWECO's own shops . . . while experienced SWECO field crews overcame mid-winter snow, mud and freezing weather to finish foundations and structural units on time. Close coordination of shop work with field work makes it possible to schedule completion in *10 months from signing of the contract to "on-stream" date.* The fine combination of pre-engineering, pre-fabrication, and field erection—perfected by SWECO for "package" refinery units . . . is typical of the imagination, ingenuity and reliability which have characterized this company's services to the process industries for more than 25 years.

For design, engineering and construction of complete "package" plants on a turn-key basis or custom fabrication of process equipment, it will pay you to consult SWECO.



Unique "derrick structure" Use of this permanent oil-well derrick type structure for the catalytic section of "package" T.C.C. units was originated by SWECO. It eliminates the need for heavy rigging equipment and substantially reduces cost of both original construction and maintenance. Shown here is a finished T.C.C. unit, engineered and constructed by SWECO for Vickers Petroleum Company, Wichita, Kansas, a nominal 6,000 barrel "package" unit similar to the Bay Refinery job.



Shop-fabrication for field-erection Heat-exchangers, fractionators, pressure vessels and other process units for the Bay Refinery job are fabricated, assembled and pressure-tested in SWECO's own shops . . . then shipped to meet the carefully coordinated field-erection schedule.

SWECO

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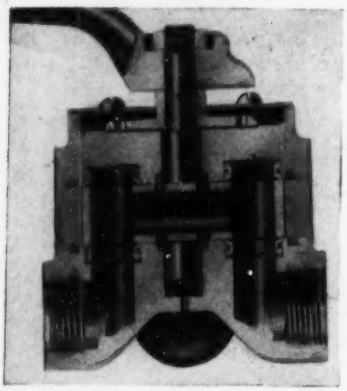
SWECO PRODUCTS

Heat Exchangers

Custom fabrication of all types of steel and special alloy vessels for the process industries.

Screen Separators.



Selector Valve

Controlled easily by hand at pressures up to 6,000 psi.

New ease of valving has been attained with the Lo-Torq selector valve for 6,000 psi. service. A 6-in. handle is more than adequate for easy turning of the disk on the 1-in. size holding 6,000 psi.

Valve consists of a body ported as desired which encases a disk having internal flow passages. Sealing rings eliminate cross leakage within the valve as the disk is revolved to produce flow through the port.

Low turning torque is obtained by balancing hydraulic pressure within the valve. Fluid reaches both sides of the rotary disk, causing it to float in its chamber. Sealing rings are designed so that positive contact is assured, regardless of flow direction or pressure.

Valve is made in sizes of $\frac{3}{8}$ to 1 in. for 0 to 2,000 psi. and $\frac{1}{4}$ to 1 in. for 0 to 6,000 psi. for most services. **—Republic Manufacturing Co., 1930 West 77th St., Cleveland 2, Ohio.** **308A**

Chemical Pumps

Available in wide range of models to fit most needs.

A new line of end-mounted chemical pumps is suitable for handling acids, caustic solutions, solvents and liquefied gases. These regenerative turbine pumps are available in 27 models suitable for heads up to 600 ft. in a single stage and capacities from 1 to 100 gpm.

All models are equipped with high-pressure flanged connections. Choice of seven different types of mechanical seals can be selected, each in several combinations of metals and gasketing. Individual models are rated for NPSH characteristics at a variety of discharge heads. A wide variety of materials of construction can be specified.—**Roy E. Roth Co., 2420 Fourth Ave., Rock Island, Ill.** **308B**

Vacuum Pump

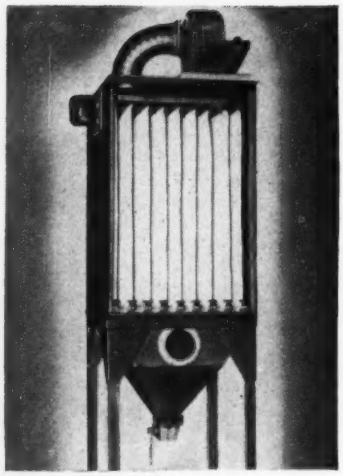
Works as high vacuum booster stage in the low-pressure range.

In the low-pressure range single-stage pumps have poor volumetric efficiency. Model MB rotary positive displacement pumps equipped with mechanical shaft seals can be used as a high vacuum booster stage in this range.

Unit is specially designed to exhaust into the inlet of a single-stage pump acting as a second-stage or backing pump. Combined unit is said to have far wider high vacuum range with lower power consumption than previously possible by commonly employed mechanical pumping principles.

First of the units to be produced is Model MB-1200. It is run in combination with a single-stage 125-cu. ft. pump to produce a blank-off pressure of 0.1 micron McLeod gage.

At one micron pressure, pumping speed is about 750 cfm. In the pressure range from 10 microns to one mm Hg, pumping speed is about 1,000 cfm. At high vacuum the combined unit requires about 5 hp., and at an inlet pressure of 15 mm. Hg. about 15 hp.—**Kinney Manufacturing Div., New York Air Brake Co., 3529 Washington St., Boston 30, Mass.** **308C**



Dust Collector

Cloth bag type is self-contained and designed for indoor use.

Where smaller volume dust collection is needed the new unit type CN cloth bag collector gives economical and efficient service. Each unit is self-contained and shipped assembled ready for installation.

Since collector is designed for indoor use, cleaned air frequently can be discharged inside the plant. Where air must be heated or cooled, this permits a distinct saving.

Bags are made of heavy weight sateen-weave cotton filter-fabric stitched vertically to form multiple tubes. Collector casings are constructed of heavy gage steel.

Seven sizes of the CN collector are available, ranging from 200 to 1,000 sq. ft. of cloth area. Sizes 200 to 500, inclusive, have one hopper and nine bags. Additional capacity is obtained by lengthening the bag. Sizes 600, 800 and 1,000 are double sections of the smaller sizes.—**Pangborn Corp., Hagerstown, Md.** **308D**

For More Information . . .

about any item in this department, circle its code number on the Reader Service Postcard inside the back cover.

Plasticizer	TRIETHYL CITRATE	ACETYL TRIETHYL CITRATE	TRIBUTYL CITRATE	ACETYL TRIBUTYL CITRATE
Empirical Formula	$C_3H_5O(COOC_2H_5)_3$	$C_3H_4O_2(COOC_2H_5)_3$	$C_3H_5(COOC_4H_9)_3$	$C_3H_4O_2(COOC_4H_9)_3$
Molecular Weight (Theoretical)	276.3	318.3	360.4	402.5

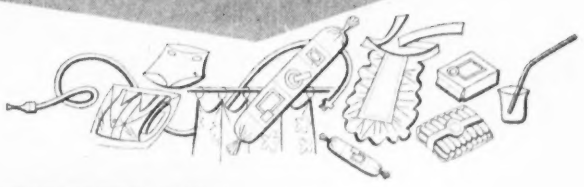
TYPICAL PHYSICAL PROPERTIES

Color	Hazen	10	<50	50	<50
Distillation Range at 1mm Hg.	Deg. C.	126-7	131-2	169-70	172-4
Refractive Index 25°C.	—	1.4400	1.4380	1.4431	1.4408
Specific Gravity 25°C.	—	1.136	1.135	1.042	1.048
Pounds Per Gallon 25°C.	lb.	9.48	9.47	8.69	8.74
Pour Point —	Deg. F.	−50	−45	−80	−75
Viscosity 25°C.	Cps.	35.2	53.7	31.9	42.7
Solubility in Water 25°C.	Gm./100 cc.	6.5	0.72	<0.002	<0.002
Solubility in Oil 25°C.	Gm./100 cc.	0.8	—	—	—
Evaporation Rate 105°C.	Gm./sq.cm./hr.	0.000676	0.000497	0.000065	0.000009

RESIN COMPATIBILITY

Cellulose Acetate	C	C	P	P
Cellulose Acetate-Butyrate	C	C	P	P
Cellulose Nitrate	C	C	C	C
Ethyl Cellulose	C	C	C	C
Polyvinyl Chloride	C	C	C	C
Polyvinyl Chloride-Acetate	C	C	C	C
Polyvinyl-Vinylidene Chloride	C	C	C	C
Polyvinyl Acetate	C	C	C	C
Polyvinyl Butyral	C	C	C	C
Chlorinated Rubber	C	C	C	C

P = Limited Compatability C = Compatible



WHEN TOXICITY IS A PROBLEM A CITRATE PLASTICIZER•MAY BE THE ANSWER

● Pfizer offers this group of four Citrate Plasticizers . . . each with special properties that determine its use. They are especially recommended for vinyls and cellulosics.

Studies indicate these plasticizers have an extremely low order of toxicity. This characteristic suggests their use in hospital equipment, food packaging, beverage tubing and other products in which toxicity is a factor.

If you need a plasticizer for a specific application, investigate these Pfizer Citrate Esters. Send for Technical Bulletin No. 31.

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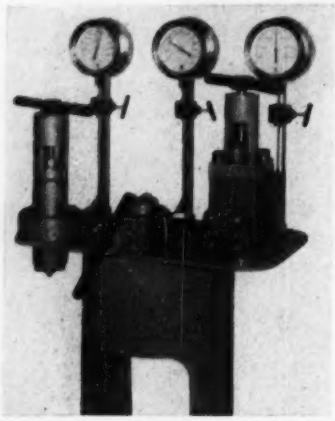


High-Pressure Valves

Now available as standardized units for plant size operation.

Three standard design valves in pressures from 6,000 to 30,000 psi have been thoroughly tested and are now in production. Valve on left, above, is designed for 30,000 psi. It has ⅜-in. diameter port and non-rising stem. Once the valve is opened, it operates on 25-ft.-lb. torque; closing requires 8 ft.-lb.

Peak capacity of center valve is 6,000 psi. It has ¾-in. port and rising stem. Torque of 25 ft-lb. opens valve. It is available also in larger sizes.

On the right is a valve for working pressures up to 15,000 psi. Port is 13/16 in., and stem is non-rising. Operating torque, once valve is open, is less than 5 ft.-lb. This design is available in larger sizes.

All valves shown are furnished with Teflon impregnated packing. After being pressurized at rated capacity for a full month, they do not show any pressure drop.–**Autoclave Engineers, Inc., 860 East 19th St., Erie, Pa.** **310A**

Exhaust Blowers

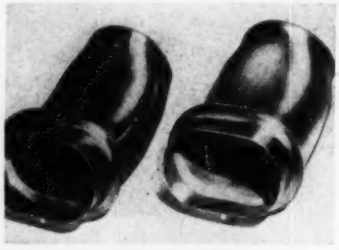
Are protected against corrosion and abrasion by coatings.

Two complete lines of exhaust blowers now are available for abrasive and corrosive service.

One line designed for service ranging from simple ventilating to handling of moderately corrosive atmospheres is available in capacities from 300 to 7,000 cfm. Protective coating can be chosen from either baked phenolic, vinyl or tough latex material.

A second line of heavy-duty rubber-covered blowers for severely corrosive or abrasive conditions ranges in capacity from 750 to 54,000 cfm. Choice of several types of high-grade rubber, including natural and neoprene, protects the units against sulfuric, hydrofluoric, and other rough mineral acids.

Paddle type fans are dynamically balanced for smooth operation. They maintain efficient suction despite varying static losses in the over-all system.–**Heil Process Equipment Corp., 12901 Elmwood Ave., Cleveland 11, Ohio.** **310B**



Stainless Steel Tubing

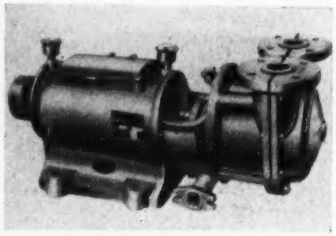
Now fabricated free of seams and porosity with high tensile strength.

Fabricating methods have been devised for producing high-tensile-strength stainless-steel tubing in a variety of configurations. Although light in weight, tubing can withstand extreme heat and high pressures.

As an example of the gain in strength compare standard and high-strength stainless steel straight wall tubing. The latter gains greater yield and tensile strength for the same wall thickness through a work hardening process.

For example, in order to carry maximum working pressure of 500 lb., a tube 3-in. O.D. would need a wall thickness of 0.025 in. However, with the new high strength tubing the same pressure can be carried with wall thickness of only 0.015 in. This means a weight saving of 40 percent.

Picture illustrates by two different views how an old-style brazed fitting looks in comparison with a new one-piece fitting.–**Flexonics Corp., 1315 South Third Ave., Maywood, Ill.** **310C**



Chemical Pump

Primes itself after initial manual priming

No priming of the suction line is required in the new RE-Sa chemical pump. Designed for emptying vats, tank cars, acid containers, and deep subterranean tanks pump draws liquids over considerable heights.

Wetted parts of the pump are made of alloys best suited to withstand corrosion on the specific application, and require little, if any, maintenance.

Pump normally is equipped with flanges. Hose connectors are available on request.–**Neumann & Welchman, 37 Wall St., New York 5, N. Y.** **310D**

Compressor

Driven by turbocharged gas engine gains boost in power.

The new 2,000 hp. Type 412 KVS turbocharged gas engine compressor is said to be 50 percent more powerful than the largest previous 4-cycle gas engine driven compressor. Utilization of turbocharging makes possible more power combined with compact size and economical performance. Unique crankshaft design with compound crankpins also contributes to reduced size and weight.

Exhaust gases drive gas turbines coupled to centrifugal blowers located at either end of the engine. Air from the blowers scavenges the cylinders and cools pistons and valves at the end of the exhaust strokes. At the end of the intake stroke the cylinders contain air compressed to 4 psi. by the centrifugal blowers.

Compressor cylinders are located on one side of the engine. Thus there is unrestricted access to the other side of the engine.–**Ingersoll-Rand, 11 Broadway, New York 4, N. Y.** **310E**

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Jenkins cast steel Valves

for dependable economy

in high pressure

—higher temperature services

Mounting pressures and temperatures in power generation and industrial processing call for Cast Steel Valves. For this increasing need, Jenkins offers a wide selection of patterns that have met the test of the toughest services throughout industry.

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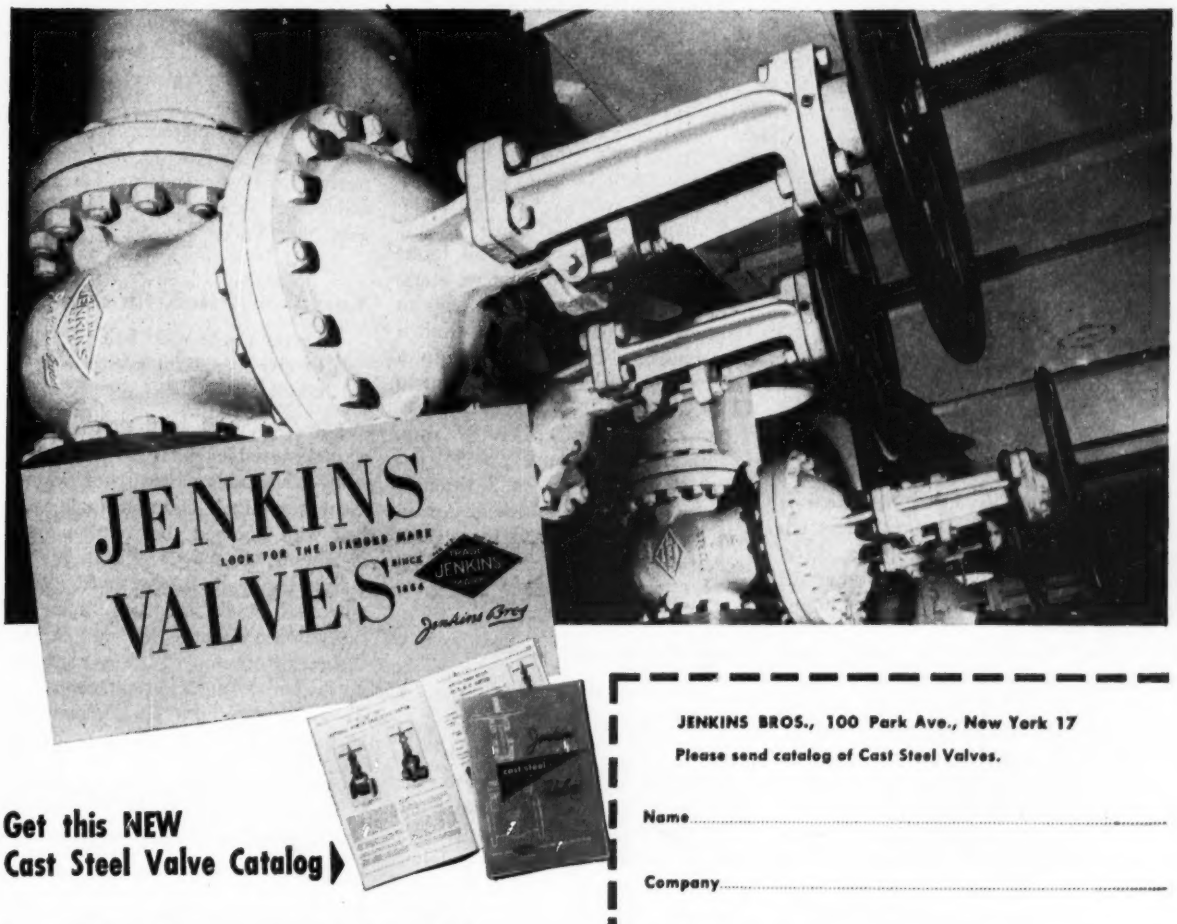

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Describes Globes, Angles, Gates, and Checks with detailed pressure ratings, dimensions, and other technical data covering all patterns of Cast Steel Valves now available from Jenkins. Send the coupon for your copy.

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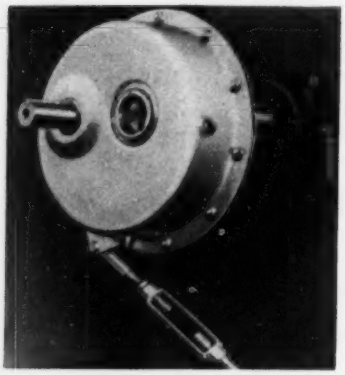


Speed Reducer

Mounts on shaft has all steel construction.

A new speed reducer mounts directly on the shaft to be driven. Only sufficient floor space is needed for the motor and tie rod connection.

Reducer easily adapts to various shaft diameters. Choice of single or double reduction unit makes possible selection of almost any output speed between 420 and 14 rpm.

Six sizes cover the range from ½ to 30 hp. Construction is all steel with highly efficient helical gearing and positive lubrication.–**The Falk Corp., Milwaukee, Wis.** **312A**

Variable Speed Drive

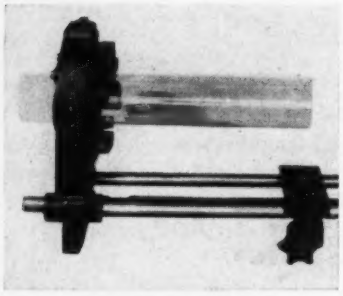
Through electronic control achieves precise d.c. speed control from a.c. supply.

Highly precise speed regulation is obtained with the new stepless adjustable-speed Select-A-Spede drive. Unit operates from a.c. power lines to drive standard NEMA d.c. motors, ¾ to 15 hp.

Unit consists of an anode transformer, electronic control panel, pushbutton station and a specially designed adjustable speed d.c. drive motor. Drive is built with speed ranges of 5:1, 20:1 or 50:1 with 100:1 available for some applications.

Speed regulation is claimed to be especially precise. When the unit is used with optional tachometer feedback equipment, regulation will be ±½ percent.

Optional control features include inching, jogging, threading speeds, control acceleration and deceleration, dynamic braking and reversing. Drive motor and pushbutton station are available in any desired enclosure.–**Louis Allis Co., Milwaukee 7, Wis.** **312B**



Glass Working Lathe

Fits need for specialized glass work in laboratory and plant.

Adaptable for use either as a horizontal or vertical lathe this machine handles a broad range of glass-working needs. On it can be made ring seals, tees, flanges, tapers, glass fusings, closures and a variety of repairs.

A unique sleeve grip chuck permits quick setups of practically all forms of glass work without elaborate accessories.. Tubing of any length up to 100 mm. dia. can be mounted through the spindle. Extension bars grip a variety of glass shapes and sizes up to 12 in. dia.

Normal chuck speed is 32 rpm. Length between chucks is 36 in., radial clearance 8 in., and through-spindle dia. 4 in.–**Bethlehem Apparatus Co., Inc., Front and Depot Sts., Hellertown, Pa.** **312C**

Cup Packing

Combines resilience of rubber with toughness of leather.

Cup packings for high-pressure, high-temperature hydraulic and pneumatic systems now are made from leather impregnated with a liquid polymer. Resultant material combines resilience of rubber with toughness of leather.

Polymer is a solventless liquid that can be impregnated into leather then cured at room temperature converting it to an elastomer.

Packings identified as Vim No. 1243-311 perform at pressures from 0 to 15,000 psi. at temperatures of –65 to 200 deg. F.–**Thiokol Chemical Corp., 780 North Clinton Ave., Trenton, N. J.** **312D**

Seal Cage

Made in one piece of Teflon snaps around shaft.

A new one-piece flexible Teflon seal cage has been developed for use with stuffing boxes on pumps, mixers, reactors and other types of processing equipment. Cage overcomes handicaps experienced with two-piece metal lantern rings. Being flexible it is easily snapped over shafts without dismantling pump or pulling shaft. It will not scour shafts even at high speeds; will last considerably longer than metal rings.

Chempro seal cages are available in standard or special sizes to fit any pump, mixer or agitator.–**Chemical and Power Products, Inc., 11 Broadway, New York.** **312E**

Variable Pitch Sheave

Drives single wide belt to give maximum horsepower efficiency.

For drives in the 5 to 20 hp. range a new variable pitch sheave offers many advantages where speed adjustment is required. Use of a single wide belt with notched construction gives maximum horsepower efficiency.

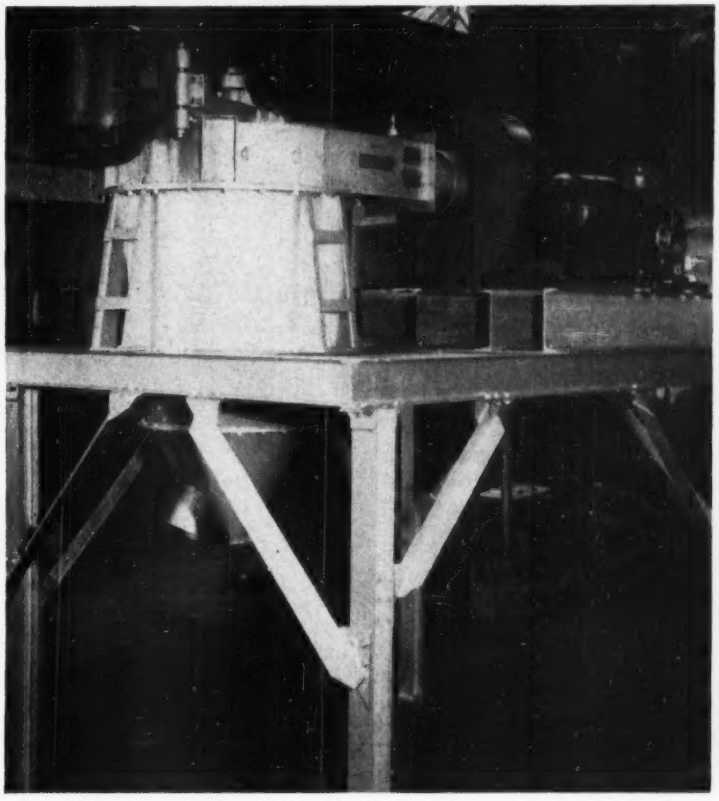
Speed can be varied over a 3:1 range. A single adjusting screw is easily accessible at either end of the sheave. Rotation of screw acts to move both flanges simultaneously.–**T. B. Woods Sons Co., Chambersburg, Pa.** **312F**

For More Information . . .

about any item in this department, circle its code number on the Reader Service Postcard inside the back cover.

NEW TYPE STURTEVANT AIR SEPARATOR

Recovers Fines in Micron Ranges



Now the famous Sturtevant Whirlwind Air Separator, so widely used throughout industry for fast recovery of fines, has been specially designed to "pick-off" classified materials such as pigments, limestone fillers, plastics, oyster shells, etc., in micron sizes.

These highly efficient air separators select a continuously uniform product of desired fineness. Used in a closed circuit with grinding mills, they increase production, cut power costs.

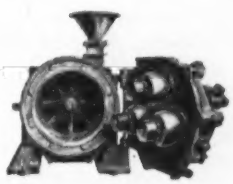
Large feed opening, rugged construction, ease of adjustment, low power consumption assure economy of operation and minimum upkeep. Write for further information.

STURTEVANT
MILL COMPANY
100 CLAYTON STREET
BOSTON 22, MASS.

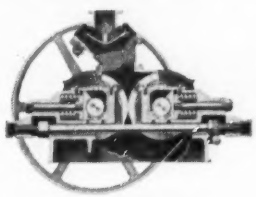
Designers and Manufacturers of:
CRUSHERS • GRINDERS • SEPARATORS
CONVEYORS • MECHANICAL DENS and
EXCAVATORS • ELEVATORS • MIXERS

OTHER STURTEVANT EQUIPMENT

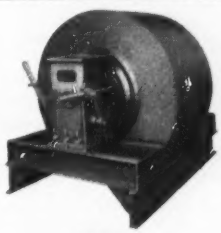
MICRONIZER ® GRINDING MACHINE
A fluid jet grinding machine, the Sturtevant Micronizer speeds reduction of materials to low micron sizes. These jet mills are especially applicable in fields where a particle size in microns is desired.
Sturtevant Micronizer grinding machines are available in many sizes and capacities.



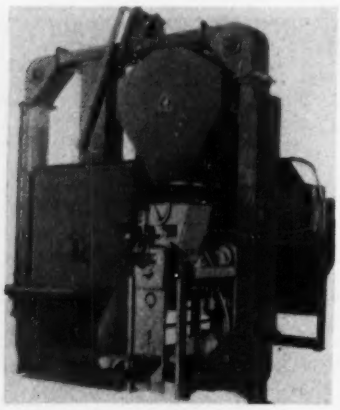
RING-ROLL MILLS
For medium and fine reduction (10 to 200 mesh), hard or soft materials. Very durable, small power. Operate in closed circuit with Screen or Air Separator. Open door accessibility. Many sizes. No scrapers, plows, pushers, or shields.



CRUSHING ROLLS
For granulation, coarse or fine, hard or soft materials. Automatic adjustments. Crushing shocks balanced. For dry or wet reduction. Sizes 8 x 5 to 38 x 20. The standard for abrasives.



BLENDER
Four-way mixing action assures a thoroughly blended product. Open-door accessibility permits easy cleaning. Available in many mixing capacities for ¼-ton per hour and up.



Complete Mixing Unit

Produces uniformly blended batches of dry chemicals or minerals.

A line of complete package mixing plants is available to handle batches from 500 to 4,000 lb. Plants consist of ribbon mixer with cut-in hopper, elevator, conveyor, stacking bin, motor drives and controllers. Available as extra is valve bag packer pictured above. Packers for open mouth bags and drums also can be furnished.

One 15-hp. motor drives the entire unit. Unit can be adapted readily to various flow plans that may differ from the one pictured above.—**John W. Williamson & Son, 1545 South Greenwood Ave., Montebello, Calif. 314A**

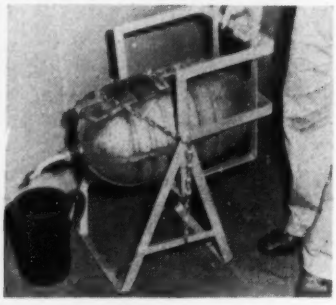
Bulk Unloader

Provides fast easy handling of bulk materials from car to storage.

Conveying up to 40,000 lb. per hr., the Vacu-Veyor offers a fast, efficient means of bulk unloading. It will convey a distance of 150 ft. vertically and 200 ft. horizontally.

Pickup nozzle is designed to maintain a constant strong vacuum on many types of materials. Adjustable air intake opening provides the proper mixture of air and solids. Nozzle may be completely buried without danger of choked lines.

At the discharge end of the system solids are separated from the air stream in a cyclone unloader. Fine solids are picked up by a bag type dust collector. Air discharges through a positive displacement blower downstream from collector.—**Vacu-Blast Co., Inc., P. O. Box 885-R, Belmont, Calif. 314B**

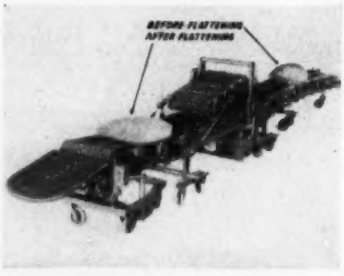


Pouring Rig

Allows liquids to be handled without danger from spilling or splashing.

Small quantities of liquid chemicals can be handled safely by using this tilter for 5- and 6½-gal. containers. It is designed as a smaller, simpler, less expensive unit than those previously available.

A chain holds the container in position when tilted. Smooth discharge is assured by the pouring spout made of acid-resistant rubber and plastic tubing. Spout fits openings from 1 to 1⅞ in. Flow capacity is slightly more than 1 gpm.—**General Scientific Equipment Co., 2700 West Huntingdon St., Philadelphia 32, Pa. 314C**



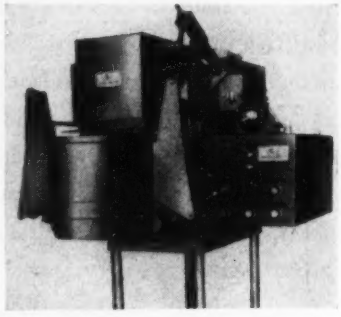
Unloading Conveyor

Flattens bags for easy storage and use of less stacking space in warehouse.

Adaptable for unloading either box cars or trucks, this conveyor has a bag flattening attachment. Bags are carried along the flexible spring conveyor through a hugger boom section which compactly flattens each bag for easy storing in minimum space. Side rails steer the bags through the flattening unit.

Conveyor pictured is 26 ft. over-all, 24 in. wide, with a 15-ft. flexible section coupled to an 11-ft. rigid section. Unit runs at 120 fpm., delivering 1,000 bags per hr.

A 1½-hp. gearmotor drives both conveyor and flattener. Discharge end is equipped with a hydraulic jack for raising and lowering when loading to pallet.—**Flexoveyor Mfg. Co., 1220 South Acoma St., Denver 10, Colo. 314D**



Production Scales

Feed wide range of dry solids to containers at high rate.

Use of a unique feeding mechanism and a reliable, shockproof leverage system enables two new filling scales to handle high tonnages. Model 1000G gross weighing and model 1000N net weighing scales were designed for flake, granular, pellet or fibrous materials. Range of bulk densities can run from 10 to 160 lb. per cu. ft.

Feeder can be attached directly to a storage bin or surge hopper. Material is conveyed through feeder at right angles to gravity flow. Thus any variation in head pressure has little or no effect on the weighing accuracy of the scale.

Adjustments can be made in a matter of seconds to compensate for variations in material density due to changes in formulation or batch mixes.—**Thayer Scale & Engineering Co., 492 East Water St., Rockland, Mass. 314E**

ship kid-glove chemicals
in Hackney Drums

of stainless steel
Monel Metal
or Nickel

...Tight Head or Removable Head Types

Here's the returnable shipping container to protect your sensitive chemicals, oils, and food products against contamination during shipment or in storage. Tight head or removable head Hackney Drums are available in several types of stainless steel—or in Monel metal—or in nickel. Choose the metal that treats your product best—and be sure the high purity of your product is protected all the way to its destination.

Both open head and tight head models are ruggedly built for long life and low damage claims. Both have smooth, crack-free interiors that are easily kept spotlessly clean. Can be furnished as mixing containers without I-bars, cover or clamp ring if desired.

Write for specifications and details. Ask for the new Hackney Drum and Barrel Catalog which describes Hackney engineered containers for all solids and liquids.

EASILY CLEANED—
smooth bottom chime
has no cracks

PRESSED STEEL TANK COMPANY

Manufacturer of Hackney Products

1447 S. 66th St., Milwaukee 14 • 52 Vanderbilt Ave., Room 2025, New York 17
203 Hanna Bldg., Cleveland 15 • 936 W. Peachtree St., N. W., Room 113, Atlanta 3
208 S. LaSalle St., Room 792, Chicago 4 • 553 Roosevelt Bldg., Los Angeles 17
18 W. 43rd St., Room 15, Kansas City 11, Mo. • 140 Wallace Ave., Downingtown, Pa.

Hackney
MILWAUKEE

CONTAINERS FOR GASES, LIQUIDS AND SOLIDS

GUIDED TOUR CONTINUED

PICTURED FLOWSHEET

Synthetic detergents **372**

CHEMICAL ECONOMICS

We'll need 94% more electricity by 1963..... **379**

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Synthetic detergent how-to.

Continental Oil makes alkyl aryl sulfonate from benzene and propylene tetramer by the Friedel-Crafts reaction. Here's an inside look at the integrated plant operation. (p. 372)

94 percent more power.

That's what the chemical industry will demand by 1963. Be sure to read this economic analysis of a tough problem. (p. 379)

From research to president.

That's Harry McClure, Carbide's popular new president. He's had a hand in developing over 200 organics. (p. 398)

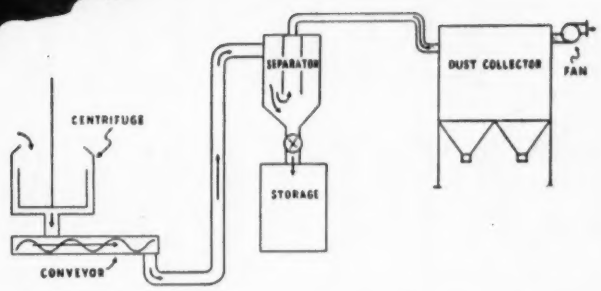
New technical literature . . .

You can now get—free and fast—literature on any subject in your field. Use our new enlarged section to keep your files up-to-date. (*Reader Service*)

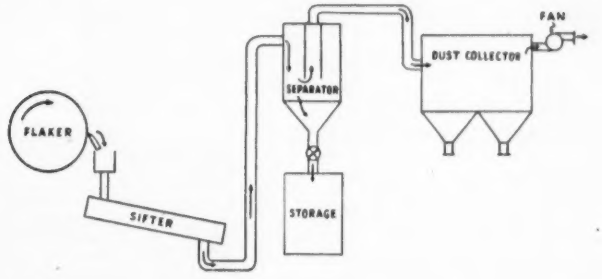
AND—Index of advertisers precedes the Reader Service section.

A MIDWEST CHEMICAL CO.

saves $112,500 annually salvages 600,000 lbs. of chemicals with

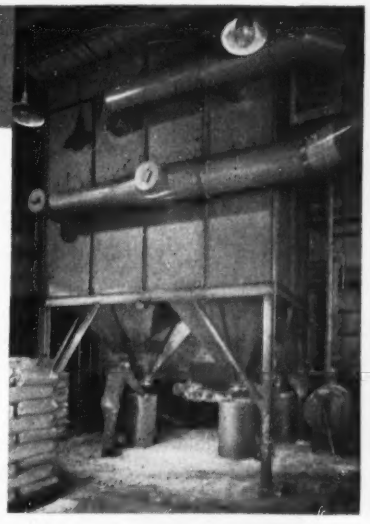


Two complete Dustube Dust Control systems are used to eliminate dust nuisances in this midwest chemical plant. In one system about 25,000 lbs. of very fine material is handled daily. From 5% to 7% of this dust escapes preliminary separators and is trapped in a Dustube Collector. As this dust is worth 15c a pound, a minimum of $187.50 is saved each day.



In the second system which ventilates chemical processing stations, a minimum of 750 pounds of valuable material is recovered each day with a Dustube. At 25c per pound, the product recovered daily has a value of $187.50.

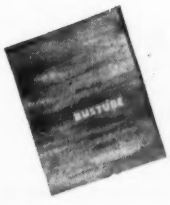
DUSTUBE dust control



The two Dustube Collectors installed at this chemical company have paid for themselves many times over with their thorough dust removal. As explained above, these collectors are saving $375.00 daily in product recovery alone.

In addition, the Dustube Collectors' highly effective filtering action traps even the finest dust with virtually 100% efficiency to keep the plant completely dust free. Their simple, practical design provides the highest efficiency at an unusually low operating cost.

Let Dustube engineers show you why users everywhere say: "It pays to own a Dustube."



Send for this 28-page Dustube brochure showing typical applications in 18 major industries.

American
WHEELABRATOR & EQUIPMENT CORP.
347 S. Byrkit St., Mishawaka Ind.

dustube COLLECTORS

EFFICIENT HEAT EXCHANGE

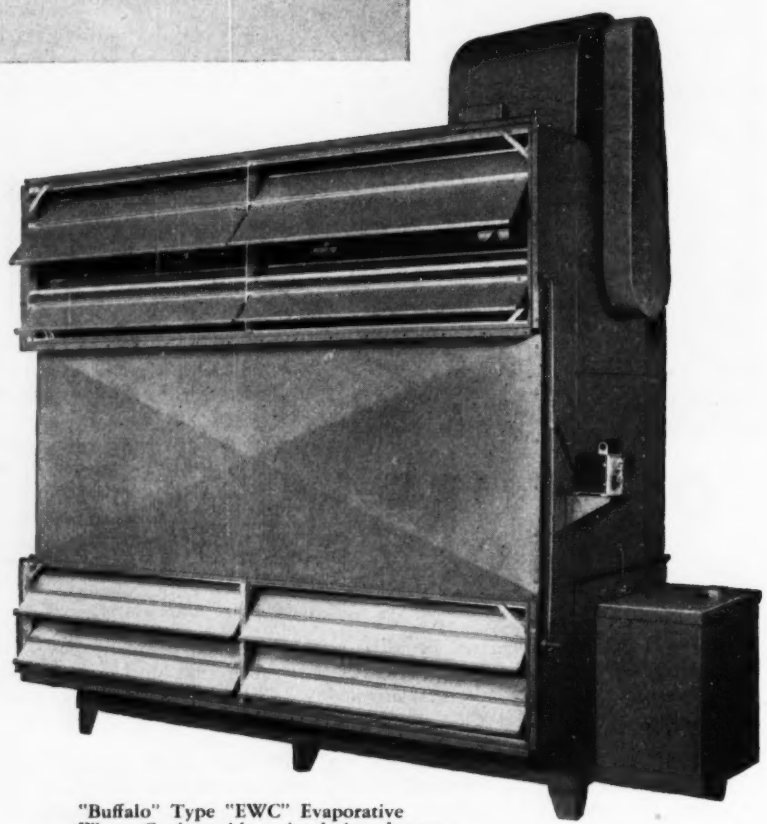
WITH MINIMUM COOLING WATER

FOR COOLING IN A CLOSED SYSTEM

- jacket water of compressors
- lubricating oils
- quench oils
- Diesel jacket water
- jacket water of natural gas and other engines

"BUFFALO" TYPE "EWC" EVAPORATIVE WATER COOLERS

are more and more the ideal answer to efficient, economical liquid cooling as water supplies become increasingly short. In these units, the liquid to be cooled passes thru a bank of coils continuously sprayed. Fan draft causes evaporation on the large surface of the coils and dissipates the heat. The results in this closed system — exceptionally high heat transfer in a highly compact unit—close control of liquid temperatures — very small makeup water requirements. "Buffalo" "EWC" units are available in capacities for cooling from 20 to 600 gpm of liquid, and are built in 3 basic, demountable sections for moving in thru standard building openings. High-quality parts, including "Buffalo" Pumps, Fans, Non-Clogging Spray Nozzles, Aerofin Coils, and heavy-gauge tank and paneling mean "Q" Factor* performance. Write today for Bulletin 3666A.



"Buffalo" Type "EWC" Evaporative Water Cooler with recirculating dampers for automatic temperature control.

The "Q" Factor — The built-in Quality which provides trouble-free satisfaction and long life.

BUFFALO FORGE COMPANY

501 BROADWAY BUFFALO, NEW YORK

Publishers of "Fan Engineering" Handbook

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.
Sales Representatives in all Principal Cities

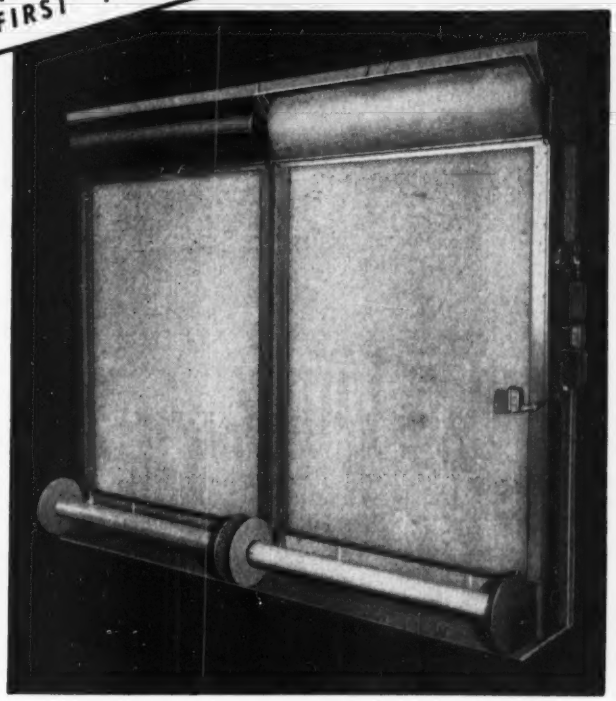
VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

INTRODUCING THE *NEW*

Roll-O-MATIC

ANOTHER AIR FILTER "FIRST" FROM AAF

A "Dry" Type Viscous Air Filter That Maintains Its Efficiency Automatically Up To One Year With One Roll of Low-Cost AMER-glas Media



A ROLL-O-MATIC filter of two 5'0" wide by 8'0" high sections—capacity 26,700 cfm.

So automatic you don't even push a button! That's the new ROLL-O-MATIC—a high efficiency air filter that maintains its established operating resistance for months on end without an hour lost or a dollar spent for maintenance.

The ROLL-O-MATIC is a viscous filter with "dry" type characteristics—combines the efficiency and simplified maintenance of a dry filter with the high dust holding capacity and velocity characteristics of a viscous unit. The filtering media is a 2" thick AMER-*glas* mat made up of continuous glass fibres sprayed with non-flammable Viscosine fluid-jell.

The AMER-*glas* media, in roll form, is mounted at top of the ROLL-O-MATIC and moves as continuous curtain down the face of the filter and re-rolled on motor-driven spool at the bottom. A pressure differential switch regulates the movement of the filter curtain so that media usage is in direct proportion to the dust content of the air. Field tests indicate that, under normal operating conditions, a single roll of AMER-*glas* should last *one year* per 10,000 cfm of capacity. But regardless of amount of media used, the cost will be less than that of throw-away filters.

Other ROLL-O-MATIC advantages are (1) lighter weight, (2) low-cost installation and (3) elimination of all drain and water connections. For complete design and engineering data, call your local AAF representative or write direct for Bulletin No. 248.

AAF

American Air Filter

COMPANY, INC.

326 Central Avenue, Louisville 8, Kentucky • American Air Filter of Canada, Ltd., Montreal, P. Q.

When you need welding fittings...

in a hurry... call your GLOBE distributor

Your Globe welding fittings distributor carries a wide variety of sizes and types in stock. As a result — he can supply you with the fittings you need . . . in a hurry

In fact, doing business with your Globe distributor is good business all around! His warehouse can be your warehouse . . . you won't have to be overloaded with a big inventory of welding fittings . . . you can reduce storeroom requirements and streamline your operations.

Make it a point to know your Globe distributor . . . a good man to deal with for all your welding fitting needs.

GLOBE STEEL TUBES Co., Milwaukee 46, Wis.

For the name of your Globe distributor, call any of these District Offices.

Chicago • Cleveland • Denver • Detroit • Glendale, Calif • Houston
New York • Philadelphia • St. Louis • San Francisco

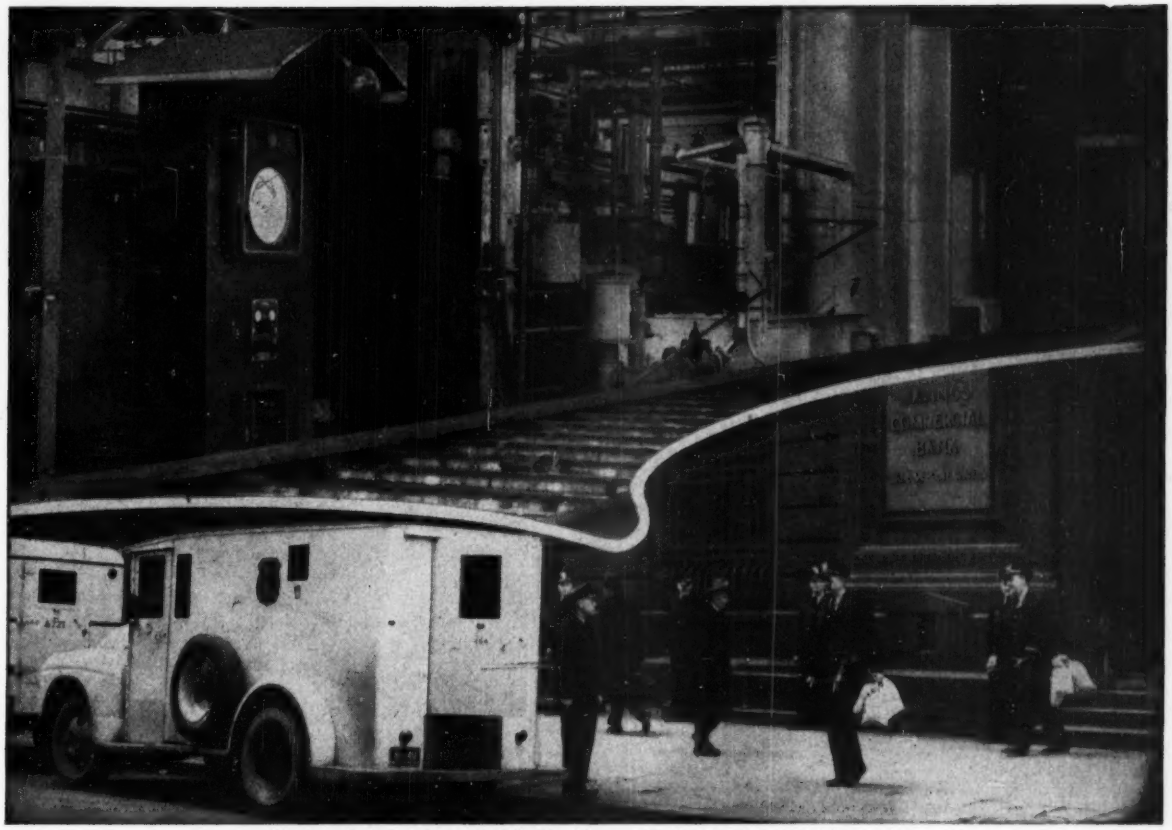
Only Globe — among manufacturers of seamless Welding Fittings— produces its own seamless tubes. Only Globe offers you precision-processed fittings through every step of production — from billet to tube to fitting.

GLOBE
PRECISION PROCESS

SEAMLESS WELDING FITTINGS

GLOBE TUBES

Producers of Globe seamless stainless steel tubes— Gloweld welded stainless steel tubes — alloy — carbon — seamless steel tubes — Globeiron (high purity Ingot iron) seamless tubes — Globe Welding Fittings



Modern Safeguards—Brink's for Money, Bailey for Process Materials

Are Your Process Materials Guarded As Well?

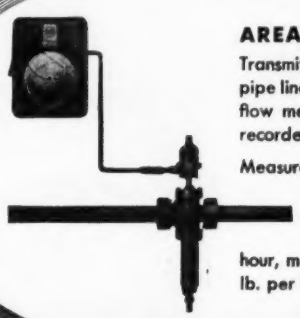
HERE'S HOW TO PREVENT SPOILAGE AND WASTE . . .

TO avoid waste of valuable process materials and finished products, process rates and conditions must be accurately measured and controlled. That's where Bailey Meters, Analyzers and Controllers can help you to improve the efficiency of your plant.

Take flow for instance. Bailey Meter Company offers a complete line of flow measuring and controlling equipment for applications ranging all the way from high pressure steam to low pressure gas. We measure flow in pipes, open channels, ducts, furnaces, smelters, kilns, ovens, dryers.

When you call Bailey Meter Company, you get the help of years of experience as well as recommendations from a wide selection of measuring and controlling devices.

Your local Bailey Engineer is as near as your telephone. He has the experience and the equipment necessary to set up an effective guard for your process materials. P-26



AREA TYPE FLOW METER

Transmitter goes into 1, 2 or 4 inch pipe line like a valve and transmits flow measurements electrically to recorder in remote location.

Measures oil and other clear liquids under static pressures up to 600 psi. Minimum range 0 to 1200 lb. per hour, maximum range 0 to 9600 lb. per hour.

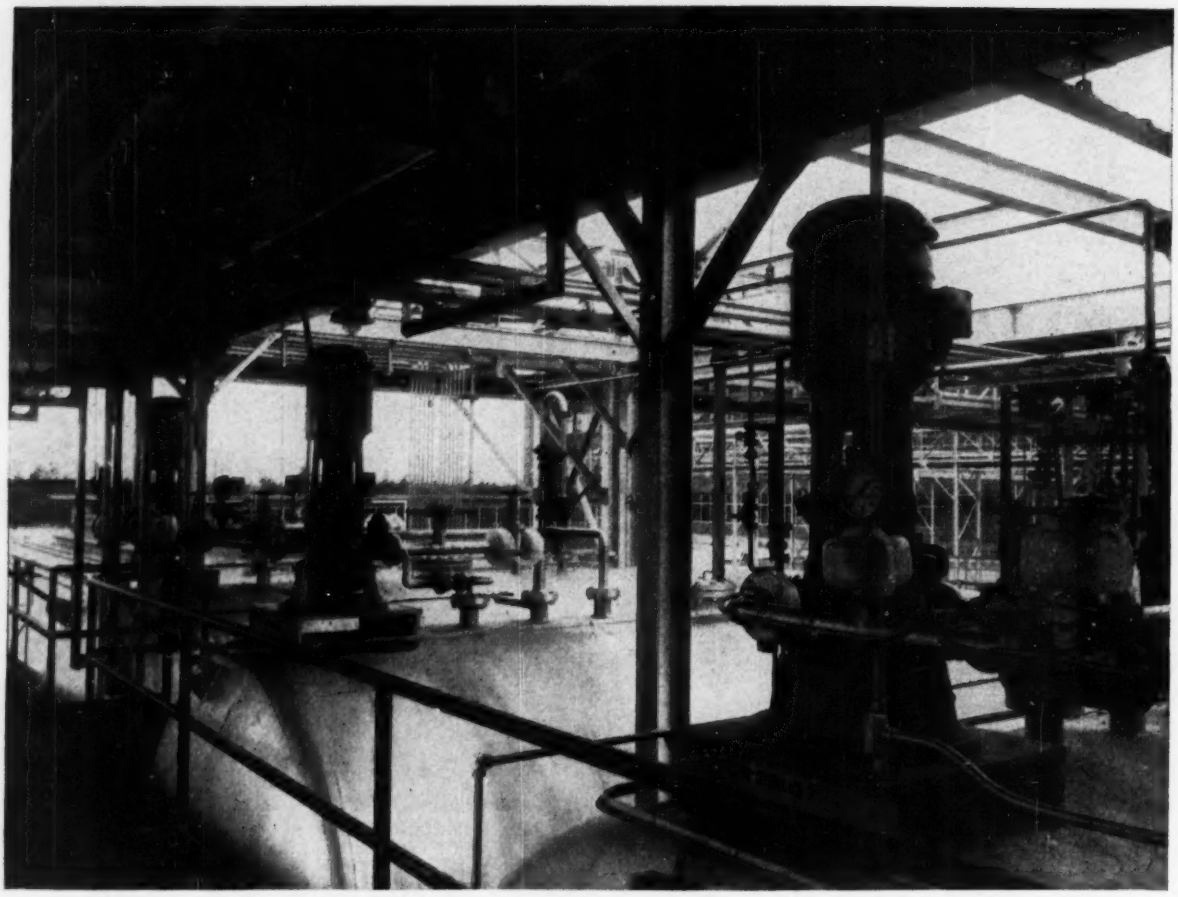
BAILEY METERS

BAILEY METER COMPANY

1054 IVANHOE ROAD
CLEVELAND 10, OHIO

Process Controls

TEMPERATURE · FLOW
PRESSURE · LEVEL
GAS ANALYSIS · [illegible]



Natural Habitat

One look at this picture tells you that the men who designed this plant knew exactly what they were doing. Layout, installation and maintenance are obviously the work of highly competent individuals, backed by a company that means business.

There are eight LaBour Type BG pumps in this complete installation at Toms River, N.J., in the plant of Ciba States Limited. One pump handles 65% oleum under a 10½ ft. static suction lift; the pump in the foreground handles 96% sulfuric acid.

It's not surprising to find LaBour pumps in a picture like this. The men who can do this kind of a job know that LaBours *belong* there. They understand that continuity of operation with minimum interruption for repair and maintenance, is the key to profit.

That knowledge is reflected throughout this plant—accounting, of course, for selection of the LaBour pumps.

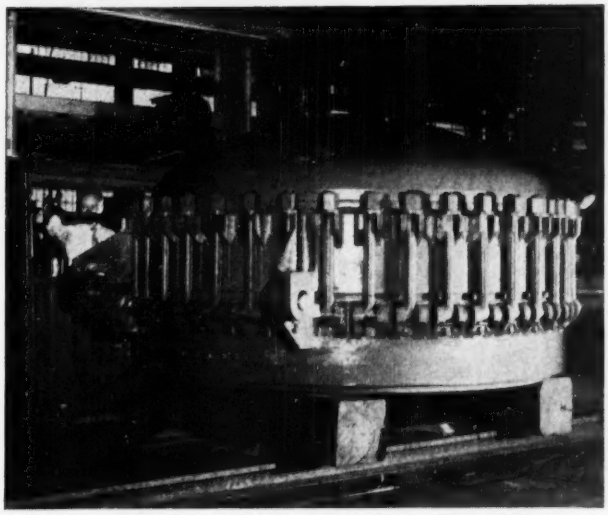
ORIGINAL MANUFACTURERS OF THE SELF-PRIMING CENTRIFUGAL PUMP

LABOUR

THE LABOUR COMPANY, INC. ★ Elkhart, Indiana, U.S.A.

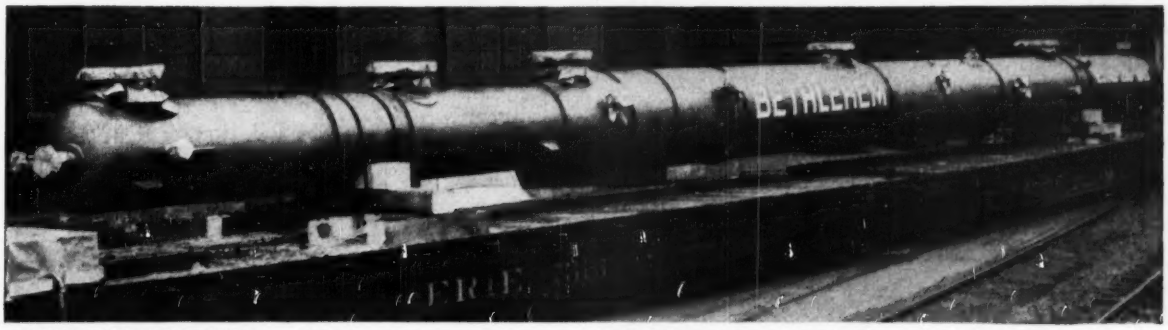
155-FOOT AUTOCLAVE—This huge vessel shown on its way from Bethlehem, Pa., to East Orange, Texas, will be used as a creosoting tower. Constructed of 0.96-in. plate throughout, it's designed for pressures up to 225 psi at 650 F.

WHAT'S NEW IN WELDED VESSELS



LOOKS RUGGED . . . AND IS!—This cylinder door and shell ring assembly is headed for a creosoting plant in far-off New Zealand. The head is made of 1¼-in. plate. The shell ring is 4 in. thick, 93 in. OD. It tips the scales at 17,789 lbs.

DESULPHURIZING TEAM—The cyclone separator on the left stands 13 ft high and weighs 5706 lbs. Its partner, a vacuum condensate tank, is almost 15 ft high and weighs just about 3¼ tons.



30-TON BUBBLE TOWER — This chemical process tower was built of heavy plates—1 1/16 in. and 7/8 in.—to handle high pressures. It was tested hydrostatically to 756 psi. Erected, it will stand over 95 ft high.

For further information about welded vessels, towers and other equipment for chemical and petroleum processing, call the nearest Bethlehem sales office.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

BETHLEHEM STEEL

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

The fittings that revolutionized pipe welding . . .

In the year 1931 Taylor Forge gave industry its *first real line* of seamless, butt-welding pipe fittings. We say it was the first *real* line because it was the first to include not only long and short radius ells, but also full branch and reducing tees, concentric and eccentric reducers, stub ends, caps and welding neck flanges.

This was a fully planned development. Many years before Taylor Forge had foreseen the future of the butt-welding fitting . . . had realized that pipe welding could not go beyond its then crude stage until pipe users were given *all* the fittings necessary to make up complete piping systems.

So Taylor Forge went to work on this and after long research and development came out with the full line that became the inspiration of modern pipe welding.

Naturally the organization that started ahead has kept ahead . . . in design, in quality, in breadth of line. That is why so many men who have followed the development of the WeldELL line, refuse to consider any other kind of welding fittings.

TF

For up-to-the-minute facts,
see your Taylor Forge distributor
513-0254

TAYLOR FORGE

TAYLOR FORGE & PIPE WORKS, General Offices and Works: P.O. Box 485, Chicago 90, Ill.
Offices in all principal cities. Plants at: Carnegie, Pa.; Fontana, Calif.; Hamilton, Ont., Canada

3 years in a row
Cooper-Bessemers help
R.E.A. Plants win top awards

For the third straight year, the DIESEL PROGRESS Bronze Plaque, for the most efficient and economically operated Rural Electrification Administration plant, goes to a co-operative equipped with Cooper-Bessemer engines.

In 1953, as in 1952, Wolverine Electric Co-op's Johnson Plant at Hersey, Michigan, was the *first* choice. Here, three Cooper-Bessemers are part of the engine team that generated power throughout 1953 at an adjusted net operating cost of only 6.48 mills per kilowatt hour. The top award of 1951 was presented to the Graham County Electric Co-op, Pima, Arizona, powered by five super-charged Cooper-Bessemer Gas-Diesels.

Eight of the fifteen awards presented during the history of the competition have gone to R.E.A. plants powered exclusively by Cooper-Bessemer units. Power for *two* additional award winning plants has been shared by Cooper-Bessemers. *Ten out of fifteen* . . . an impressive record of dependable performance, lasting economy and minimum maintenance.

Such *consistent* operating efficiency, low maintenance, and lasting economy can go to work for you, too. For heavy-duty power needs . . . Gas-Diesel, Diesel or gas engines . . . remember Cooper-Bessemer. Consult with our nearest representative who will gladly work with you on your power problems.

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DARLING VALVES

INSIDE STORY...

on trouble-free valve performance

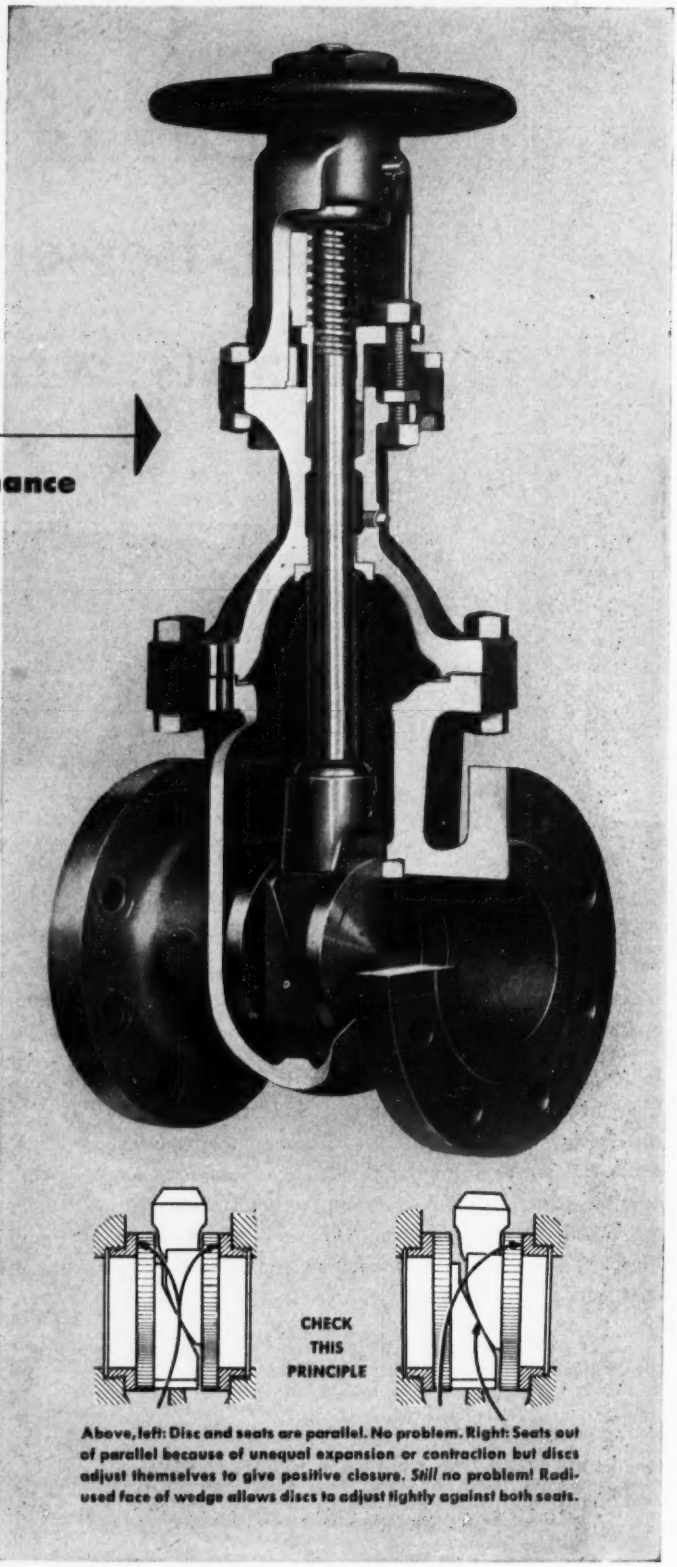
Install DARLING Revolving Disc GATE VALVES

Just what the doctor ordered . . . that's what users say about Darling fully revolving double disc, parallel seat gate valves. *Reason:* These unique valves adjust automatically to compensate for valve body distortion.

Moreover, Darling gate discs, independently hung from the upper wedge and free to revolve completely, change their seating position at each closing. This means uniform wear distribution. Valves work better and last longer, require less attention, less maintenance.

Wide Range Of Sizes And Types

If you're not already a Darling revolving disc gate valve user, let us prescribe the valve you need to cure *your* valve trouble. Darling gate valves come in a wide range of types and sizes . . . and for pressures up to 1500 pounds. Simply outline your particular service needs or ask for a complete descriptive bulletin.

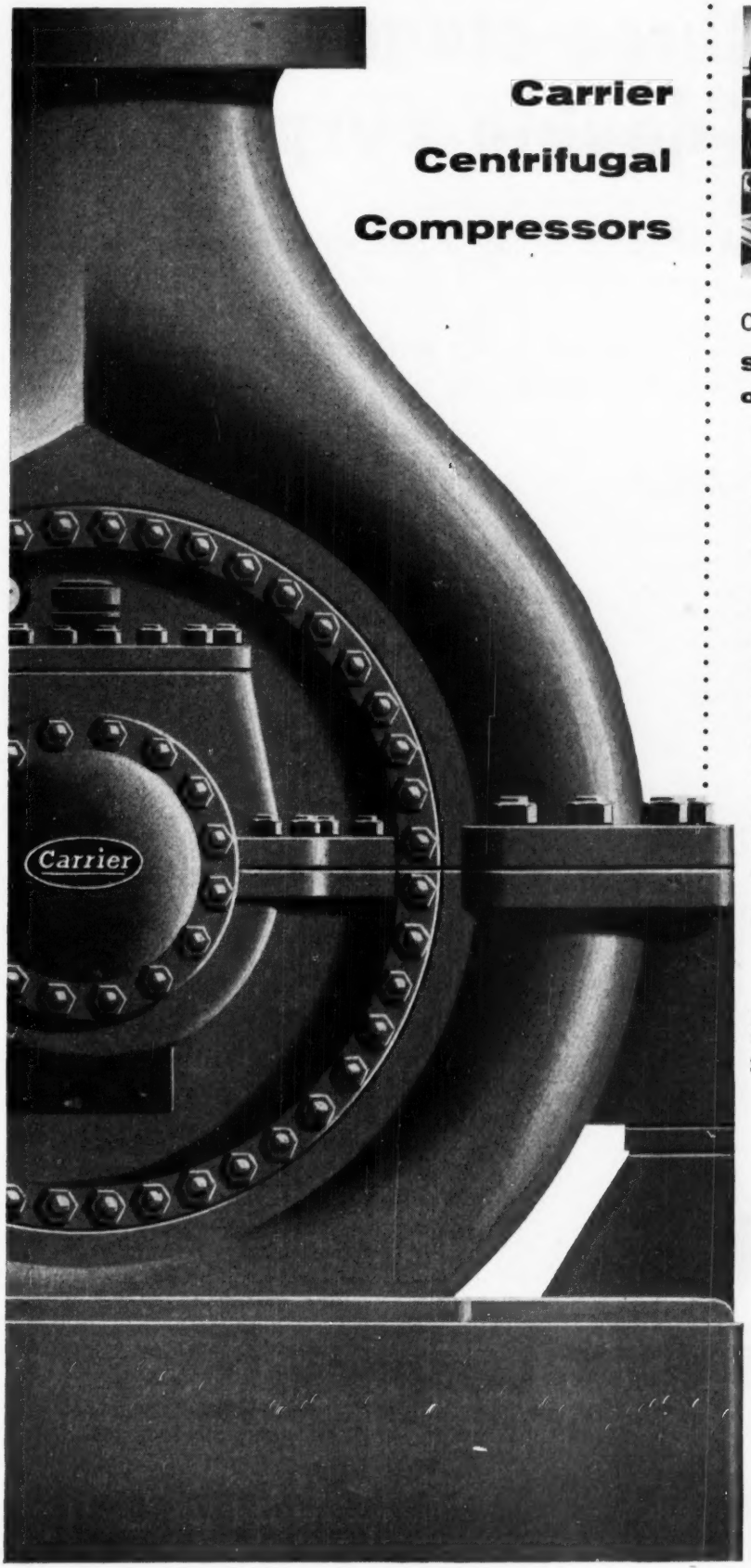


Above, left: Disc and seats are parallel. No problem. Right: Seats out of parallel because of unequal expansion or contraction but discs adjust themselves to give positive closure. *Still* no problem! Radiused face of wedge allows discs to adjust tightly against both seats.

DARLING VALVE & MANUFACTURING CO.

Williamsport 3, Pa.

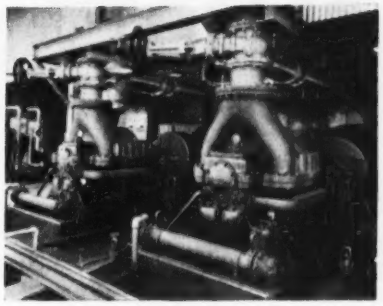
Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario



Carrier

Centrifugal

Compressors



on the job at

Standard Oil Company of California

These two Carrier Centrifugal Compressors are on the job at Standard Oil's Richmond, California, plant. Each unit handles 6000 cfm of air and operates at 7600 rpm.

Carrier makes a complete line of centrifugals for gas compression and refrigeration—up to 10,000 hp in a single unit. There are hundreds of these dependable, efficient Carrier machines on the job at dozens of chemical plants and refineries across the country—Reichhold Chemicals Company, Cities Service Company, Wyandotte Chemicals Corporation, The Texas Company. May we assist *you?*

If you'd like a copy of our booklet,

"Centrifugal Compressors for Industry,"

please call your nearest Carrier office. Or write direct to Carrier Corporation, Syracuse, New York.

Carrier

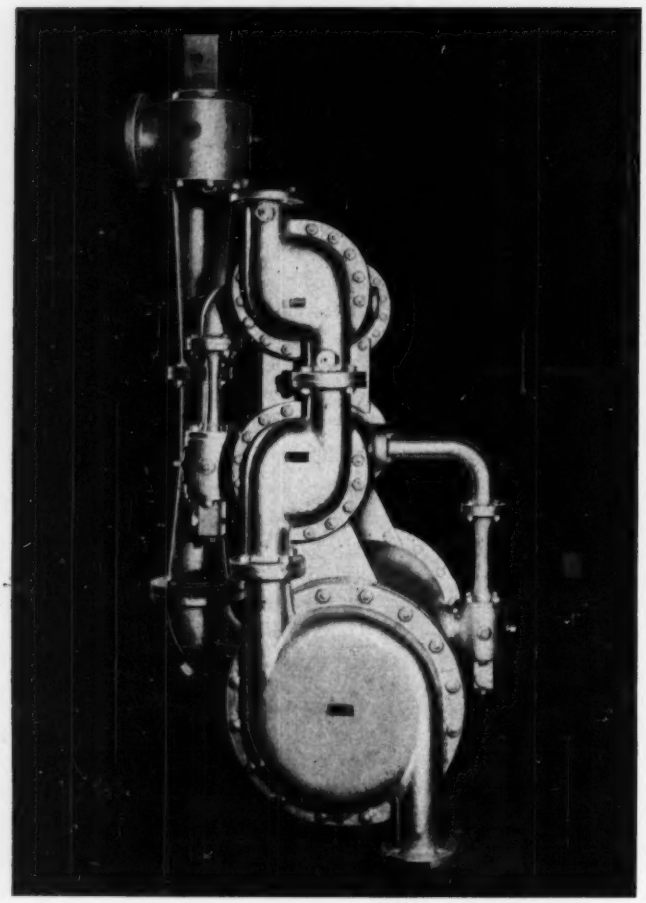
centrifugal compressors

refrigerating equipment

ELLIOTT three-stage ejector with a double purpose...

1 **To pull the vacuum required in processing a chemical product—**

2 **To recover a valuable solvent used in the process, and return it for further use.**

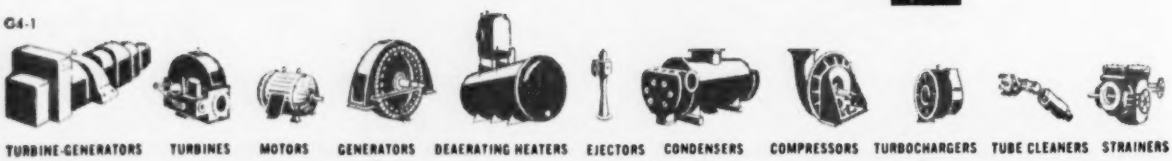


For meeting the last requirement, this unit has surface-type intercondensers, as well as an aftercondenser which recovers the solvent from the exhaust of the final stage. The set-up is enough out of the usual to call for the experienced skill of Elliott specialists in developing the unit in all its details, insuring thoroughly satisfactory performance with maximum economy. As the photo shows, the assembly is neat and compact, requiring surprisingly little space for the work it does. Furthermore, as with all Elliott ejector installations, it can be installed almost anywhere with little consideration for the convenience of maintenance, since it has no moving parts and nothing to wear.

Why not utilize the experience of Elliott vacuum engineers in your next problem? Talking it over implies no obligation. For general information, ask your local Elliott field engineer for a bulletin describing the ejector you need, or write Elliott Company, Industrial Process Division, Jeannette, Pa.

ELLIOTT Company

G4-1



TURBINE-GENERATORS TURBINES MOTORS GENERATORS DEAERATING HEATERS EJECTORS CONDENSERS COMPRESSORS TURBOCHARGERS TUBE CLEANERS STRAINERS

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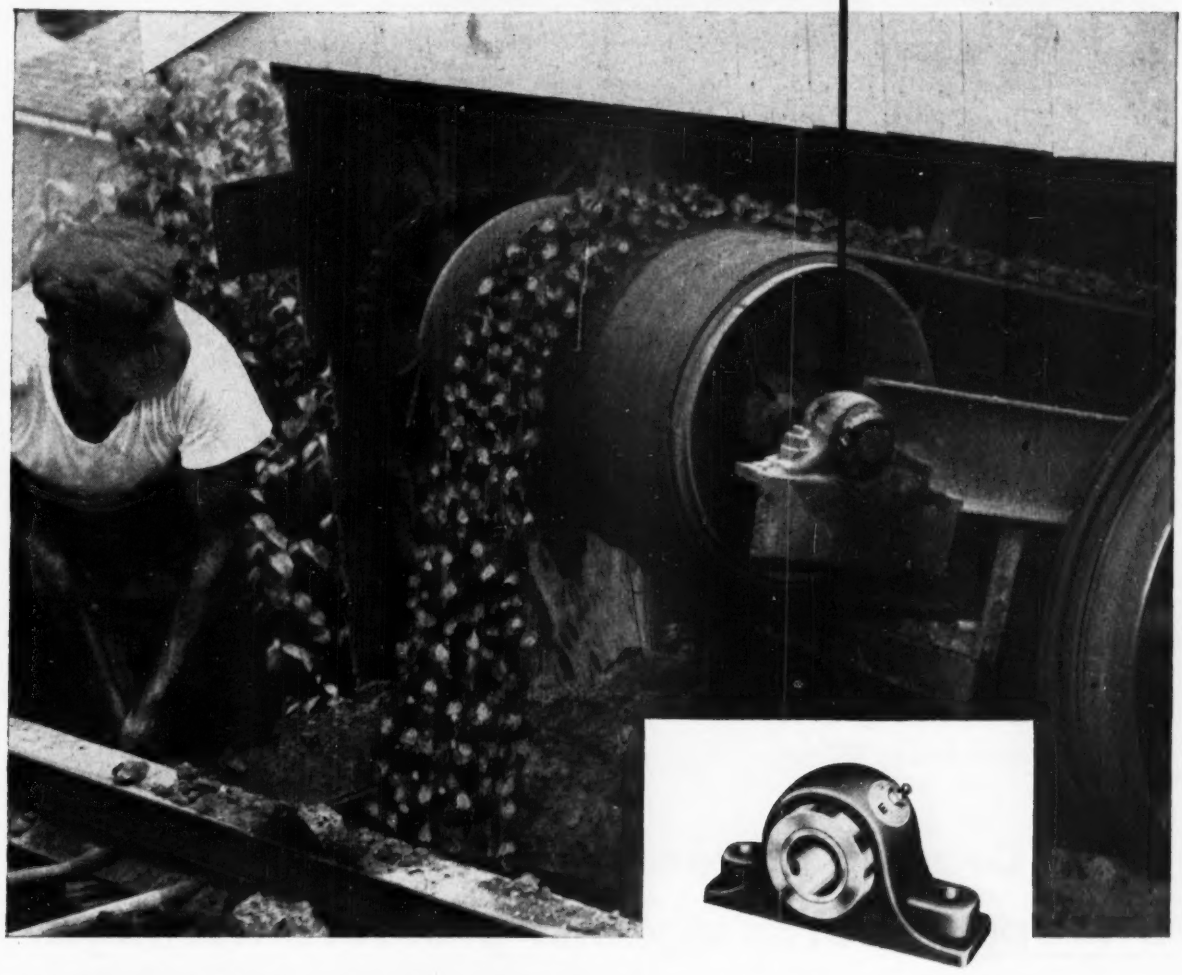
—ready to mount on the shaft!



DODGE-TIMKEN *America's Quality Pillow Block*

Extra measures are taken to build superior quality into Dodge-Timken Bearings; and extra precautions are taken to keep that quality *intact*—from the factory to distributor to you to your machines.

These bearings are sealed in manufacture—an integral part of Dodge-Timken design. Their inbuilt precision is protected *both on and off the shaft.* That is one reason why they easily deliver a minimum of 30,000 hours of service. Want evidence? Look around you. No other pillow block is so widely used on the nation's tough jobs. Dodge-Timken dependability has been proved in *millions* of installations.

There are 5 types of Dodge-Timken Pillow Blocks for all types of service, in shaft sizes from 1 3/16" to 10". Also Dodge-Timken Hanger Bearings, Flange Bearings, Take-ups.

DODGE MANUFACTURING CORPORATION, 200 Union St., Mishawaka, Indiana

DODGE

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified telephone directory, or write us.

J-M Uneepac automatic ring packing installed in Polished Rod Lubricator-Stuffing Box manufactured by Muskogee IronWorks, Inc., Muskogee, Okla.

Equipment designers of Muskogee Iron Works report:

"Greatly increased packing life . . . Uneepac guards against pressure damage"

FOR THEIR NEW LUBRICATOR-STUFFING BOXES, design engineers of Muskogee Iron Works needed a packing with long service life as well as foolproof operation. Uneepac, the Johns-Manville automatic ring packing, fully met both of these requirements and contributed to the success and acceptance which the equipment has encountered.

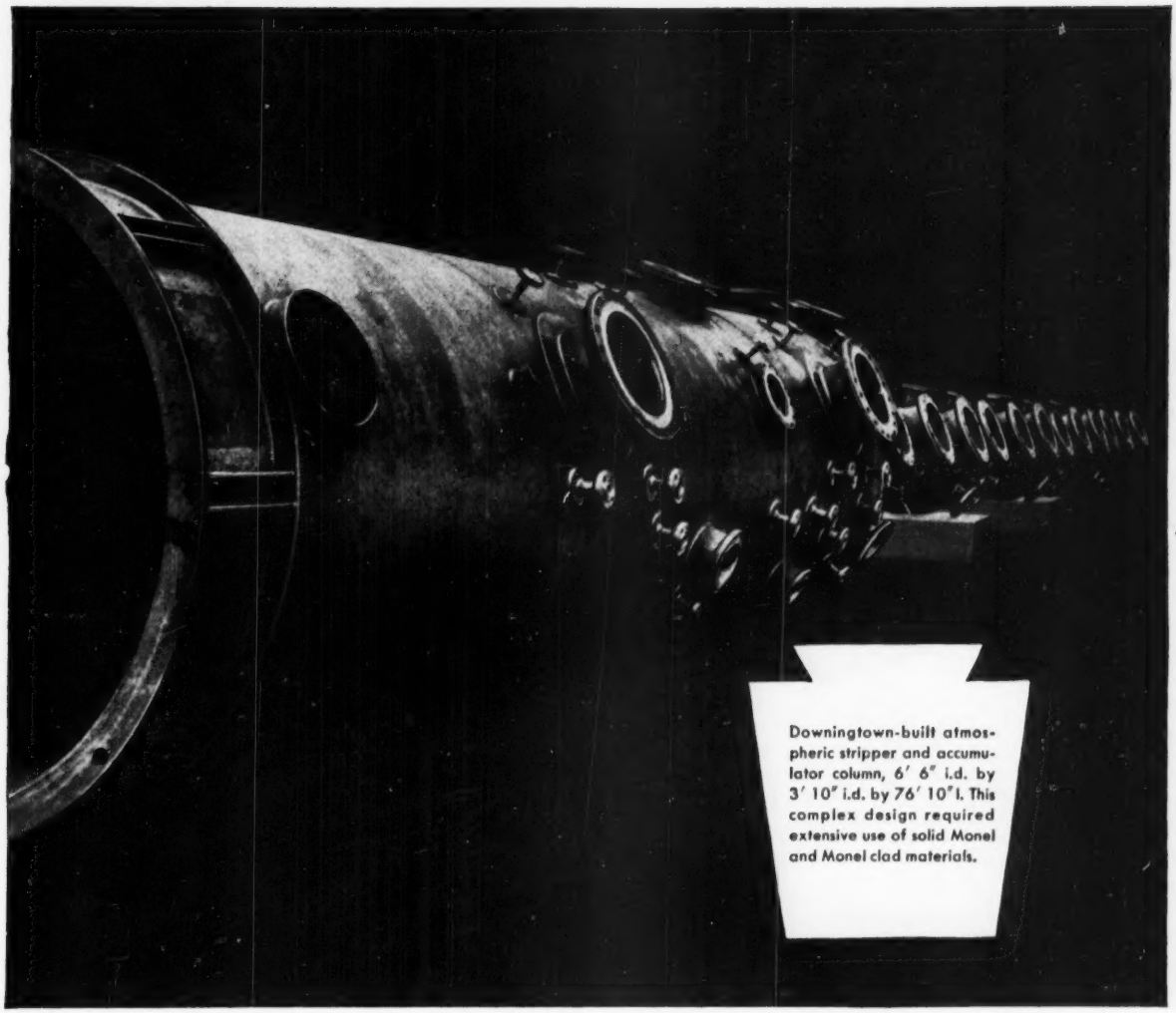
In this application Uneepac protects itself against damage by excessive gland pressure. The lips of each ring are guarded by the projecting portion of the Uneepac Center section. As a result, far greater service life and reliability is obtainable in this application than with other types of packings.

Uneepac offers many other important advantages for use in pump rods and plungers, compressors and similar equipment. Seals effectively in a minimum of space. Operates with minimum friction. Has excellent pressure sensitivity. Uneepac provides trouble-free operation because each ring positions itself diametrically as well as vertically. Header or follower rings are not always required because each Uneepac ring is a complete, self-protected unit.

To learn how Uneepac may aid your new equipment design, too, write for booklet PK-58A. Just address Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville PACKINGS & GASKETS



Downingtown-built atmospheric stripper and accumulator column, 6′ 6″ i.d. by 3′ 10″ i.d. by 76′ 10″ l. This complex design required extensive use of solid Monel and Monel clad materials.

No Design Too Complicated

Order plate fabrication from Downingtown Iron Works. That's the easy way to turn your complex designs into smooth-working process equipment—the sure way to be sure of skillful workmanship in every detail.

Downingtown is thoroughly experienced in fabricating pressure vessels from various grades of carbon steel, stainless steels, nickel clad, stainless clad, Monel clad, cupro nickel, aluminum and other materials. We've developed special welding procedures—approved by ASME for code work—which enable us to produce sound welds which are extra strong and extra neat. Welds are X-ray inspected as required by specifications.

We're set up to fabricate pressure vessels of all kinds in full compliance with ASME and other code requirements. Our experienced Engineering Department will be glad to work with you on your next project. Write for helpful literature.

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DOWNINGTOWN IRON WORKS, INC.

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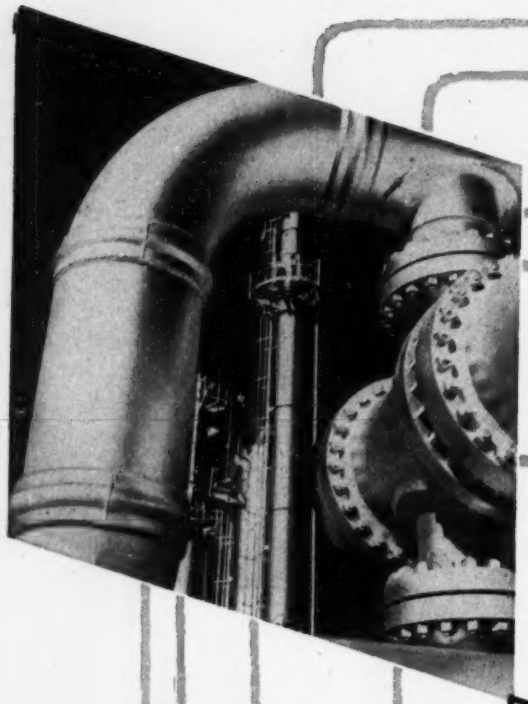

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The complicated technology required for modern chemical processing is a constant and changing challenge to the industry.

Pritchard designers, engineers and construction superintendents have proved their ability to help the industry meet that challenge. Pritchard's experienced personnel is available to you . . . to cooperate with your own engineering staff to produce the installation you need as fast and as economically as possible.

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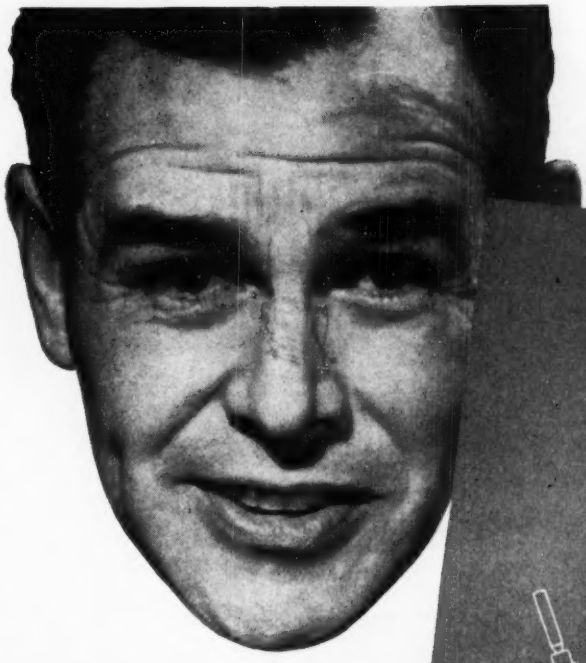

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IDEA BOOK

on **MATERIALS HANDLING?**

This 32-page, two-color brochure covers in brief, case-history fashion a broad range of engineered materials handling installations in a variety of industries. It is factually written to present basic information on a representative group of problems in materials handling. Profusely illustrated, it also contains many engineering drawings of the applications discussed.

The solution to *your* problem very probably is not here, for it is seldom that a problem in engineered materials handling can be solved by mail. But the IDEA for its solution may very well be. Why not write now, and reserve your copy from the first printing? No obligation, of course.

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WHEN YOU THINK OF **ENGINEERED** MATERIALS HANDLING . . . THINK OF **GIFFORD-WOOD**

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ELECTRIC MOTORS
... the choice of leaders in industry

SAVE maintenance dollars with Wagner Fan-Cooled Industrial Motors

HERE'S HOW—

the Wagner Cartridge Bearing Design cuts your maintenance costs:

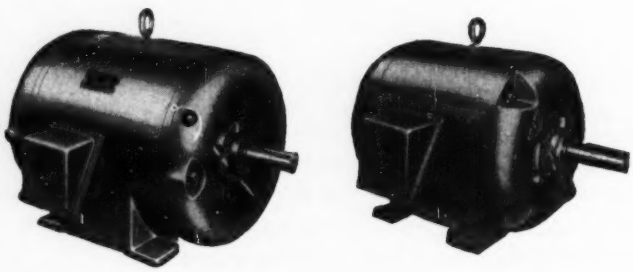
Bearings are protected at all times. The Wagner design completely encloses the bearings in a sealed cartridge. Labyrinth seals prevent the entrance of water, dirt and other foreign material. Even when the motor is disassembled, the cartridge remains intact as part of the rotor shaft. The bearing housing stays completely enclosed for full protection against dirt and dust.

Wagner Bearings can be relubricated. When lubrication is necessary to forestall premature bearing failure in unusually severe applications, readily accessible lubrication openings permit addition of grease or complete relubrication.

Wagner Bearings run longer between grease periods. Hot bearings shorten grease life. Wagner bearings have a low temperature rise because the design incorporates a deflector shield that directs a cooling stream of air around the bearing housing. Bearings run cooler and longer between maintenance periods.

This cartridge bearing design is a feature of the entire Wagner line of totally-enclosed fan-cooled motors. The line includes standard and explosion-proof steel frame motors, and standard and explosion-proof cast iron frame motors. All types are available with normal torque or high torque characteristics, in ratings to 250 hp.

For complete information—just call the nearest of our 32 branch offices, or write for Bulletins MU-132 and MU-196.



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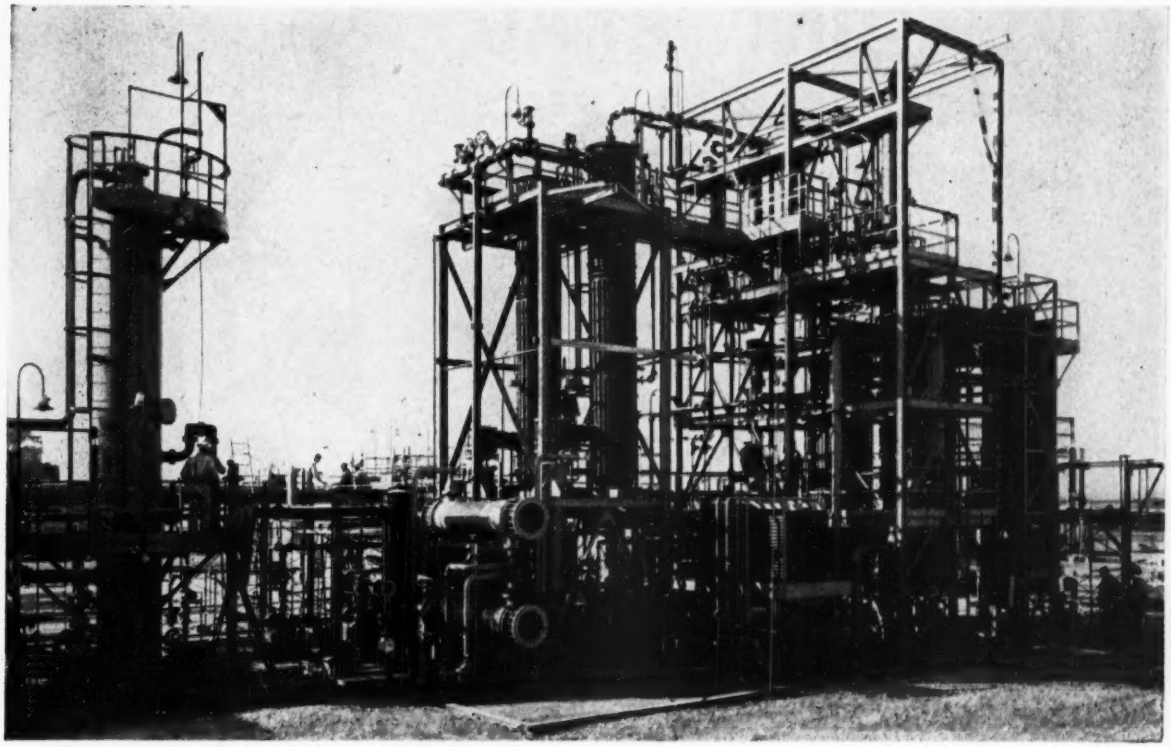

A recent petroleum chemicals plant designed and built primarily around the use of Haveg—a basic construction material that resists corrosion.

Petro-Chemical Corrosion has been Controlled!

Now for designers and engineers of petro-chemical plants there is an old and proven basic material of construction, borrowed from its 22 years of service in the chemical and metallurgical industries. It is Haveg, a plastic molded in the form of finished process equipment, or available for many types of field fabrication. Made from acid-digested asbestos and special thermosetting resins, Haveg enables you to go into a high range of process temperatures with complete safety and a proven history of outstanding performance.

Haveg has three great virtues. It is completely resistant to most corrosion. It lasts for years. It is amazingly versatile.

Not a coating or lining, Haveg gives resistance to corrosion through its entire mass, never allowing corrosives an opening wedge from cracks. It resists thermal shock, seldom requires insulation.

From steel-jacketed pressure process tanks down to the last piece of pipe, many of the petro-chemical processes can be completely contained and kept free from corrosion. Unnecessary maintenance, controls, headaches are avoided. Should plans or processes change, Haveg equipment can be machined and altered by your men, on the job. Accidental mechanical damage is easily repaired, using Haveg cement. Full chemical resistance is maintained.

If your job is fighting corrosion, get a helping hand from Haveg. Call the experienced sales engineer listed. Write for the 64-page illustrated Bulletin F-6 which contains size and chemical resistance charts, design specifications. Remember, Haveg is a logical answer to your design problems in handling petro-chemicals; in fact, in all process equipment that must handle corrosives.

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ASBESTOS-CEMENT SHEETS

Last Long, Look Good, Cost Little

No matter what your building plans, the chances are you can profitably use "Century" APAC sheets.

Being made from asbestos fiber and portland cement, APAC is fully resistant to fire and weather, rats and termites. Thus it serves equally well indoors or out—for walls, ceilings, liners, and partitions. Although its smooth, attractive surface takes decorative colors well, it doesn't require paint for protection—ever!

When it comes to cost, "Century" APAC is even more outstanding! It's made in 4′ x 8′ sheets that are easy to handle, easy to cut and drill, easy to apply with ordinary tools. This ease and speed of application does more than save you labor costs, too! APAC helps get new facilities into production faster; helps you to modernize existing structures without prolonged disruption of the work routine.

Your K&M distributor will gladly give you further details on versatile "Century" APAC sheets. Contact him soon, or write to us direct.

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K&M best in asbestos

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U.S.I. CHEMICAL NEWS

★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★

Alkyd Resin Improves Outside House Paints

Outside house paints containing a new U.S.I. alkyd resin, Aroplaz 1400, should maintain a better looking appearance for a longer time. The result of over 7 years of research and practical testing, Aroplaz 1400 is a pure, low viscosity alkyd. It can be used in either white or tinted paints in place of all or part of the oil, such as linseed, ordinarily used.

Tests indicate that paints made with Aroplaz 1400 give cleaner, whiter surfaces after exposure and that the over-all durability is considerably improved.

Aroplaz 1400, experimentally known as resin DX-159, is now in commercial production and is supplied at 100% solids content. U.S.I. offers detailed information to paint manufacturers who wish to make independent investigations of this unique new resin.

Promising Sunscreen Is Introduced For Cosmetics

A new development in filters for ultraviolet light, particularly useful for sunscreen cosmetics, has been announced by U.S.I. The material, known as H-124S, is (butyl carbityl) (6-propyl piperonyl) ether. Safe for application to the skin, the new product is a practically odorless oil of extremely low volatility. It is chemically stable as well as stable to the action of ultraviolet light, and also shows excellent solubility characteristics.

H-124S stabilizes esters presently used in sunscreen compositions. The promising compound can be used by cosmetic manufacturers alone or, preferably, to supplement the absorption range of existing sunscreen materials. Of great importance is the fact that it does not screen out tanning rays. Further information on H-124S as a sunscreen can be obtained by writing to the editor of *U.S.I. Chemical News.*

New Plastic Windows Keep Themselves Clean

A new type of plastic window has been designed for industrial and public buildings. The windows are said to be self-cleaning, shatterproof and translucent. They are glazed on one side only and transmit diffused, glare-free light. Casement-type windows are available in various sizes to fit all standard casement frames, according to the manufacturer. The windows snap into place.

Rubber Process Improves Safety of Retreaded Tires

Retreaded tires reportedly can now give the same skid protection and traction as new tires. A new process puts skid resistance and traction into the rubber at the factory before it is shipped to the retreading shop.

The company claims that the new tread rubber gives 30 per cent more surface traction than retreads in wide use today, with at least equal tread mileage.

Interest Renewed in CPR Products As Truck and Garden Insecticide Due to No Build-Up of Immunity

Synergized Rotenone and Pyrethrins Regain Preferred Position

Increasing reports of build-up of acquired resistance or so-called "immunity" by insects against some insecticides has resulted in renewed interest in CPR dusts and sprays. CPR is a combination of piperonyl cyclonene, pyrethrins and rotenone, and the synergistic action of piperonyl cyclonene increases the effectiveness of the combination beyond the sum total of the three insecticides individually.

Because of its recognized effectiveness combined with low toxicity — all three ingredients being of a low order of toxicity — CPR has enjoyed a preferred position in control of many insects, particularly in the garden and truck crop field. In the sweeping upsurge of newer chlorinated hydrocarbons, many growers risked the greater toxic hazards to avail themselves of the residual killing power of these insecticides.

Rotenone in Short Supply

Reports of insects building an immunity to these insecticides have increased in each season. First it was flies, then mosquitoes and more recently other insects such as the cabbage caterpillar. The result has been a resurgence of rotenone, which had long been the basic insecticide of these growers. In the intervening time, however, supplies of rotenone have become critical and it became apparent that the extra effectiveness of synergized rotenone could serve as the best method for extending the supply and in-

MORE

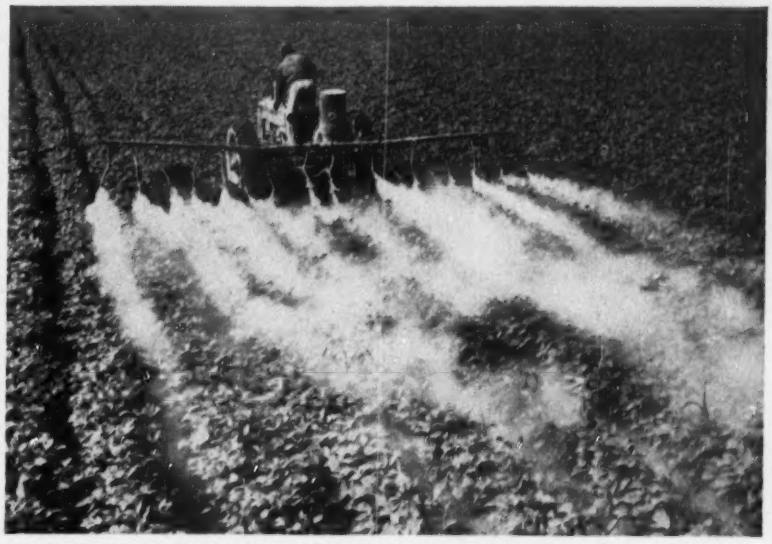
Methionine Increases Growth Rate of Infants

Infants fed half-again as much DL-methionine as their diets normally would contain gained 20% more weight in a month's time, according to a recent report. These results further illustrate the strategic role methionine plays in the metabolism of fat, protein, sulfur and water.

The group of infants between the ages of three and four months was given supplemental methionine at the rate of 180 milligrams a day. Another group receiving the same basic diet, without methionine, was studied for purposes of comparison. The extra methionine produced no unfavorable reactions.

Table of Elements Revised

A new periodic table of the elements has been prepared with improvements in layout and arrangement. This is said to be particularly true with respect to the complicated placement of atomic weights and numbers in relation to the symbol of the element.



Application of CPR dust to beans with a tractor operated dusting machine. CPR products control insect infestation in such a manner that produce is free of hazardous toxic residues.

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U.S.I. CHEMICAL NEWS

CONTINUED

New Interest In CPR Products

creasing the results.

Not only are pyrethrins and rotenone helpful in "activating" each other, but both of them give a synergist action in combination with piperonyl cyclonene.

New CPR Products

Four new CPR spray products for use on garden and house plants are being introduced to the market for insecticide formulators in 1954, in addition to the dust base and spray concentrates previously available from U.S.I. With these products, formulators can obtain standardized combinations of ingredients for which all labeling and test data is complete.

The convenience of these combinations works two ways: in providing the formulators with supplies which meet known standards for each and all of the ingredients, and second in providing research-supported claims for the product he sells.

The commercial grower of beans, cabbage, cauliflower, broccoli, squash and cucumbers finds the CPR products can control insect infestation in such a manner that the produce will be free of hazardous toxic residues. And the home gardener wants an insecticide which will control a wide range of insects. There is increasing evidence that one of the advantages of the botanical insecticides such as CPR lies in the fact that they are not so destructive to natural parasites of insects.

This was recently reported on in *Pyrethrum Post* with reference to the work of Dr. C. P. Clausen of the University of California. According to the journal, "Clausen has concluded, after a review of different workers' observations, that botanical insecticides are superior to inorganic materials wherever repeated application is made. He believes that such materials as rotenone and pyrethrum kill only the adult parasites present on foliage, and nothing further. He points out that chemical and biological control measures may sometimes be incompatible, sometimes supplementary." These new developments are all contributing to the renewed interest and new products based on CPR.

Ultrasonics May Be of Use In Pharmaceutical Industry

The use of ultrasonics holds real potential for the pharmaceutical industry, according to a recent report. The most promising use of ultra-sound in the industry is thought to lie in its application to problems which have not been solved by other physical and chemical processes. One possibility is said to be in the production of emulsions and suspensions in materials previously refractory to such treatment. Another is in the production of vaccines, where experiments have shown that intact undenatured antigens can be extracted ultrasonically from the microorganisms responsible for tuberculosis and other diseases.

Alkylating Agent Helps In Synthesis of Organics

A new method for making many alkylated compounds has been developed. Described as promising for the preparation of lubricants, additives, plasticizers, therapeutic agents and surface-active agents, the method uses an alkylating agent which can be obtained from commercial vegetable oils.

The alkylating agent, according to researchers, is a long-chain alkyl group. It can be used to alter the molecular structure of such varied organic types as phenols, mercaptans, alcohols, amines, salts and benzene.

Gold Discs Burst At Low Pressures

Gold is now being used to manufacture low-pressure rupture discs. Gold discs reportedly have been found to burst consistently at low pressure, be immune to corrosion and yet be economical. They are said to be accurate to within 5% for bursting pressures above 50 psi and to within 2 psi for bursting pressures less than 50 psi.

Since the precious metal is reclaimable, the cost of the discs does not differ greatly from base metal discs.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

An insect repellent packaged in an Aerosol container is said to give positive protection against mosquitoes, black flies, chiggers and many others. It is described as virtually odorless after application and safe for clothing. **(No. 1040)**

A new line of laboratory glassware is described as smaller than regular glassware, but not in the micro range. **(No. 1041)**

Antibiotic bandages are now available without a prescription. Impregnated with a combination of three antibiotics, they have been approved for sale by the Food and Drug Administration. **(No. 1042)**

For tapping, deephole drilling, lathe machine cutting or hand reaming on any metal, a blend of chemicals is said to free the tool and permit continued rotation and pressure. According to the manufacturer, less tool breakage and cleaner threads, surface and holes are the result. **(No. 1043)**

Aluminum transport cans may replace stainless steel cans for storing and transporting chemicals, pharamaceuticals and food products. The lightweight cans are described as seamless and easy to clean and have an airtight seal. **(No. 1044)**

Gas and air leaks can be detected by a liquid which penetrates rust scales and cracks, forming bubbles where the leak occurs. The liquid is claimed to be nonflammable and nonexplosive. **(No. 1045)**

A nonionic detergent soluble to a degree in most oils has been developed. It will be manufactured in a commercial grade for the textile, general cleaning and oil additive trades, and according to the report, a refined product will be produced for the cosmetic industry. **(No. 1046)**

Erbium oxide is reported to be available at a minimum purity of 98%. Principal impurities are fractional percentages of dysprosium, holmium, thulium, ytterbium and yttrium oxides. **(No. 1047)**

Serological baths with a temperature control closer than 0.4° C. have been marketed. The base and walls are claimed to be free of heating elements, which have been placed beneath the stainless steel tank. **(No. 1048)**

Single crystal germanium is now in commercial production. The crystals are described as homogeneous in electrical as well as crystal properties, not only on a gross scale but also on a microscopic scale. **(No. 1049)**

PRODUCTS OF U.S.I.

ALCOHOLS
Amyl Alcohol (Isoamyl Alcohol)
Butanol (Normal-Butyl Alcohol)
Fusel Oil — Refined
Propanol (Normal-Propyl Alcohol)

Ethanol (Ethyl Alcohol)
Specially Denatured—all regular and anhydrous formulas
Completely Denatured—all regular and anhydrous formulas
Pure—190 proof U.S.P., Absolute—200 Proof
Solox*—proprietary solvent—regular and anhydrous

ETHERS
Ethyl Ether, U.S.P.
Ethyl Ether, Absolute—A.C.S.

ACETONE—A.C.S.

ANSOLS
Ansol* M
Ansol* PR

ACETIC ESTERS
Amyl Acetate—Commercial and High Test
Butyl Acetate
Ethyl Acetate—all grades
Normal-Propyl Acetate

OXALIC ESTERS
Dibutyl Oxalate
Diethyl Oxalate

PHTHALIC ESTERS
Diamyl Phthalate
Dibutyl Phthalate
Diethyl Phthalate

OTHER ESTERS
Diatol*
Diethyl Carbonate
Ethyl Chloroformate

RESINS (Synthetic and Natural)
Arochem*—modified types
Arofene*—pure phenolics
Aroflat*—for special flat finishes
Aroflint*—room temperature curing phenolic
Aroplaz*—alkyds and allied materials
Aropol*—copolymer modified alkyds
Ester Gums—all types
Natural Resins—all standard grades

INSECTICIDE MATERIALS
Allethrin
CPP Concentrates: Liquid & Dust
Piperonyl Butoxide
Piperonyl Cyclonene
Pyrenone* Concentrates: Liquid & Dust
Pyrethrum Products: Liquid and Dust
Rotenone Products: Liquid and Dust

INSECTIFUGE MATERIALS
Indalone*
Triple-Mix Repellents

INTERMEDIATES
Acetoacetanilide
Acetoacet-ortho-chloroanilide
Acetoacet-ortho-toluidide
Acetoacet-para-chloroanilide
Ethyl Acetoacetate
Ethyl Benzoylacetate
Ethyl Sodium Oxalacetate

FEED PRODUCTS
Calcium Pantothenate (Feed Grade)
Choline Chloride
Curbay B-G* 80
DL-Methionine (Feed Grade)
Niacin, U.S.P.
Riboflavin Concentrates
Special Liquid Curbay*
U.S.I. Vitamin B_{12} and Antibiotic Feed Supplements
Vacotone* 40

OTHER PRODUCTS
Acetaldehyde
Caustic Soda
Ethylene
IPC (Isopropyl-N-Phenyl Carbamate)
CIPC
Liquid Chlorine
Metallic Sodium
Methionine (Pharm.)
N-Acetyl DL-Methionine
Nitrocellulose Solns.
Propionaldehyde
Propionic Acid
Sulfuric Acid
Urethan, U.S.P.

*Reg. U.S. Pat. Off.

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers Products Corporation

120 BROADWAY, NEW YORK 5, N. Y. BRANCHES IN ALL PRINCIPAL CITIES

DESIGN and PRODUCTION NEWS

FOR PLASTICS AND MATERIALS ENGINEERS

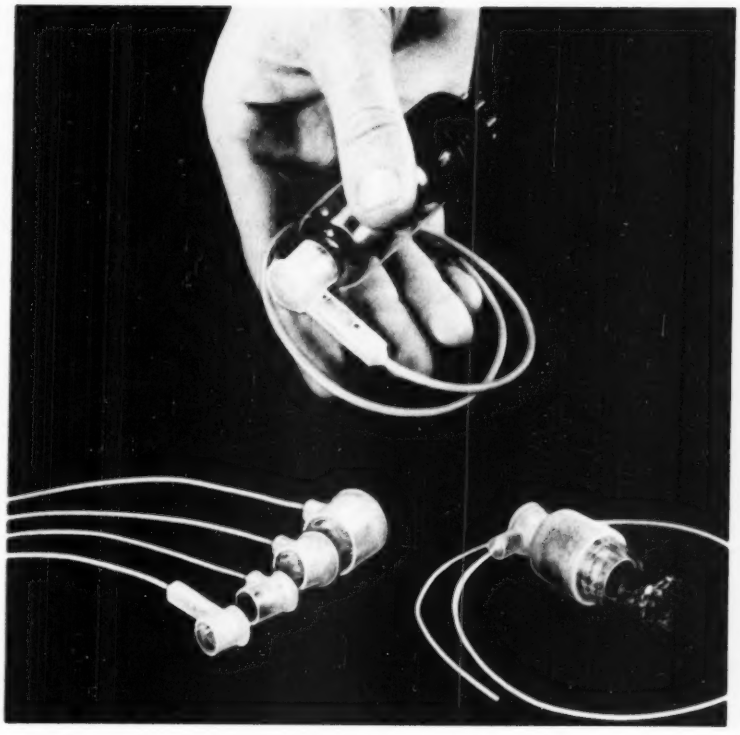
Published by TECHNICAL SERVICE, Chemical Manufacturing Division, The M. W. KELLOGG Company JUNE-JULY, 1954

New Cap Connectors of KEL-F® Polymer Widen Tube Service Range... Cut Altitude, Moisture "Arc-Over"!

Exceptional moldability of KEL-F and special equipment permit the "insert" molding of grid cap leads and resistors into a one piece insulated jacket. Conventional wire holes are eliminated, preventing insulation "pull back". Zero moisture absorption of KEL-F polymer and the elimination of wire holes precludes moisture collection which formerly caused "arc over" under high humidity.

The high insulation resistance and dimensional stability of KEL-F polymer over a wide temperature range (minus 320°F to plus 390°F) permits use of these connectors in critical installations subjected to extremes of temperature.

Alden Products Company, Brockton, Mass., uses KEL-F trifluorochloroethylene and a special molding technique to produce an entire series of connectors. Variety includes top- or side-connected leads, with or without resistors.



For further information ask for Application Report E-124

NEW LOWER PRICES FOR "KEL-F" POLYMERS OPEN UP MANY NEW APPLICATIONS POSSIBILITIES!

This is the fourth important price reduction since the introduction of KEL-F polymer products in 1948. It cuts prices up to 25% in ton lots, and as much as 42% for small quantities nominally used for experimental work.

The reduction is made possible by the rapidly expanding acceptance of KEL-F polymers and the manufacturing economies achieved in Kellogg's new production facilities.

NEW PRICE SCHEDULE—Effective May 17, 1954

	High Density	Low Density	Plasticized
1-99 pounds	$10.00	$9.50	$11.00
100 - 1999 pounds	9.50	9.00	10.50
2000 pounds and over	9.00	8.50	10.00

F.O.B. Jersey City

® Registered trade-mark for The M. W. Kellogg Company's fluorocarbon Polymers.

(SEE REVERSE SIDE)

CONTINUED FROM PRECEDING PAGE

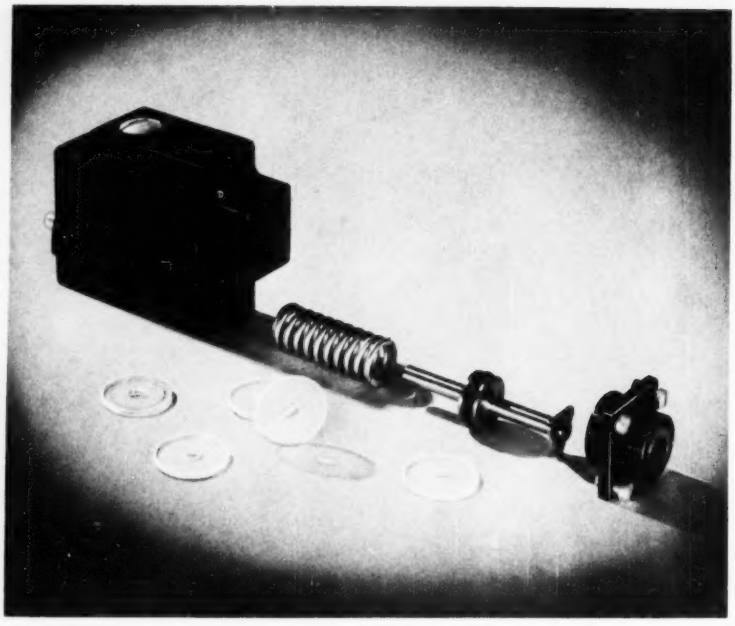
Poppet Valve-seats of KEL-F® Polymer Withstand High Gas Pressures, Repeated Impact in –65°F +160°F Service

Despite air pressures as high as 700 psi and repeated poppet impacts of 45 pounds, air control valve-seats molded of KEL-F polymer now provide seating over time periods in excess of other materials. The material's desirable characteristics of resiliency, impact resistance and dimensional stability are maintained over the entire service temperature range of minus 65°F to plus 160°F. Other critical seat requirements could be satisfied only by this unique fluorocarbon plastic.

KEL-F polymer, tough and resilient over a temperature range of minus 320°F to plus 390°F, takes higher mechanical loads than other seat materials without cracking or distorting.

The Reiss Manufacturing Company, New York, N. Y., molds sheets of KEL-F polymer Grade 300 from which valve seats are made by Air Associates, Inc., Teterboro, N. J.

For further information ask for Application Report P-102



Molders & Fabricators of the Month

Leading molders, extruders and fabricators specialize in the production of materials and parts made of "Kel-F" . . . each month this column will spotlight several of these companies with their principal services and products.

International Resistance Company
Philadelphia, Pa.
Extrusion, Compression, Transfer & Injection Molding
Terminals, Resistors, electronic components
Extruded Rod & Tube
Molded Rod, Tube & Sheet

Surprenant Manufacturing Company
Clinton, Mass.
Extrusion
Insulated Wire
Extruded Rod, Tube & Spaghetti
Tape, Strip & Monofilament

Tri Point Manufacturing & Developing Co.
Brooklyn, N. Y.
Machining

The United States Stoneware Company
Akron, Ohio
Corrosion Control
Dispersion Coating

Recent Significant KEL-F Polymer Developments . . .

"Lug" type pressure rupture discs now use extruded film not only to protect discs against corrosion damage, but as pressure and vacuum seals.

Wavemeter test probes (microwave control) use molded insulation for consistent performance in high humidity and under thermal cycling.

Heater coils and plates for severe chemical service are protected with "baked on" coatings of KEL-F polymer dispersions.

Indexed commutators for computors now consist of a molded plastic cylinder with intricate conductive inserts. High dielectric and non-carbonization of polymer improves performance.

Visit the KEL-F **POLYMER EXHIBIT** *at the 6th Annual Plastics Show. June 7-10 • Cleveland, Ohio*

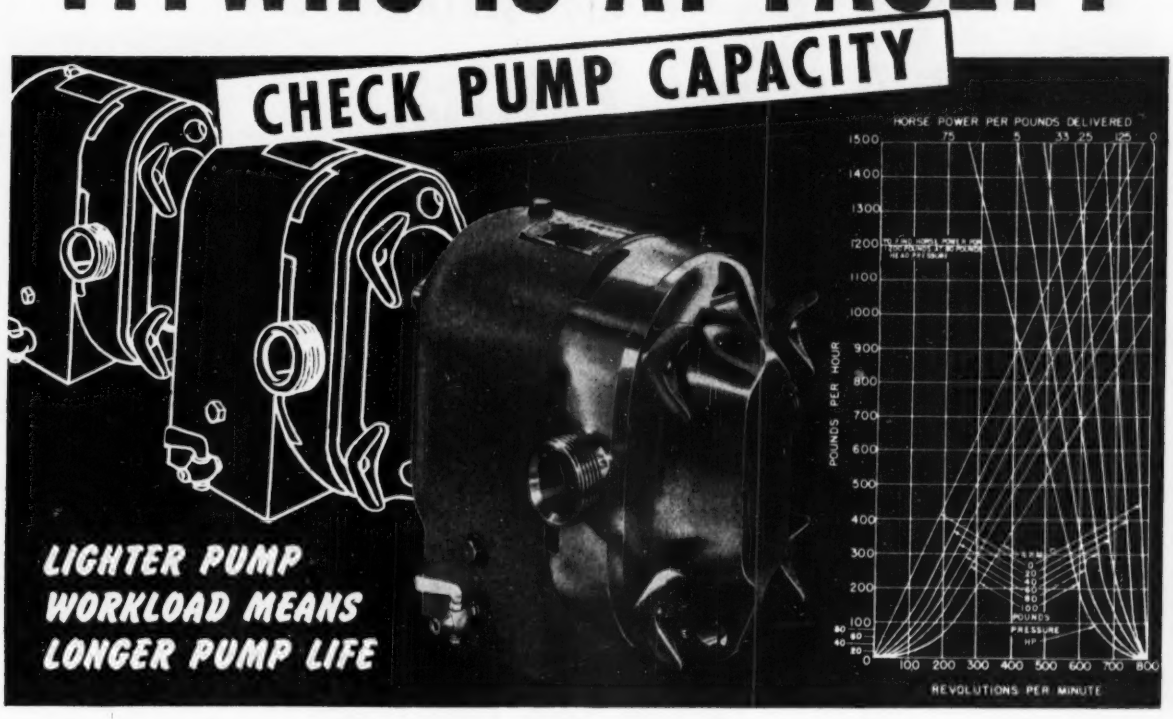
For complete information regarding any item mentioned in DESIGN AND PRODUCTION NEWS, ask for detailed APPLICATION REPORTS, write

Technical Service
CHEMICAL MANUFACTURING DIVISION
THE M. W. KELLOGG COMPANY
P. O. Box 469, Jersey City 3, N. J.
or offices in Boston, Chicago, Dayton, Los Angeles and New York

KELLOGG PULLMAN

® Registered trade-mark for The M. W. Kellogg Company's fluorocarbon Polymers

WHEN PUMPS WEAR OUT ...WHO IS AT FAULT?



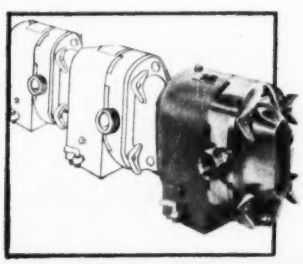
Your automobile may be engineered for 100 miles an hour speed, but operating at "cruising" speeds provides you with many more miles of trouble-free motoring. It's the same with a Waukesha P.D. Sanitary Pump. Operating at peak capacity shortens its life.

Of course, the best safeguard is to engineer your installation carefully beforehand, so that your choice of pump has sufficient capacity to handle any variation in your line above the "average." Remember, also like any mechanical device your pump is subject to wear, chambers become larger, with consequent loss in capacity. So this should be compensated for in planning — along with known factors of quantity of product to be moved, viscosity of product, vacuum, head pressures, amount of piping, bends and elbows, check-valves and screens — and any other details affecting pumping capacity.

So, to keep pump maintenance down, watch your load factors and avoid overloading. If your pump is operating at its peak now, re-check your system to see if it can be rearranged to bring it down to the pump's "cruising" range. Write for latest Instruction Hand Book — or new catalog.

*P.D. — Positive Displacement — Slow Speed

Waukesha P. D. Sanitary Pumps In a wide Range of Capacities



Whether you need 100 or 60,000 lbs. per hour pumping capacities, there's a Waukesha P.D. Sanitary Pump to fill your needs exactly. V-Belt drives, Variable Speed models with Reeves or U.S. Varidrive — they all provide product protection in non-aerating, non-agitating, non-recirculating pumping efficiency.

WAUKESHA FOUNDRY COMPANY, 1342 LINCOLN AVENUE, WAUKESHA, WISCONSIN

Waukesha 100% SANITARY PUMPS

Dependable Product of a Responsible Manufacturer

HIGH STRENGTH IS POUNDED INTO WATSON-STILLMAN FORGED STEEL FITTINGS

Forged-Fiber Grain Structure Gives Added Protection Against Piping Failures

Watson-Stillman fittings are drop-forged. Hot steel billets are hammered and pounded and squeezed in hardened dies to form the solid fittings. This operation produces a dense, tough-fiber structure with exceptionally high tensile and impact strength... higher than can be obtained by other processes. W-S Forged Steel Fittings offer maximum resistance to pressure, heat, corrosion, shock and vibration... give you strong, tough, trouble-free joints.

Watson-Stillman Fittings are designed for high strength, too... with extra heavy sections where you need them. And they're precision machined to insure perfect alignment and tight joints.

For safe, reliable service... for greater protection against costly shutdowns... install Watson-Stillman Forged Steel Fittings. Available in SCREW-END and SOCKET-WELDING types in carbon, stainless and alloy steels.

Sold Through Leading Distributors

WATSON-STILLMAN FITTINGS DIVISION
H. K. PORTER COMPANY, INC.

Roselle, New Jersey

Dependable Source for Chemical Raw Materials

Richard T. Trelfa (left), technical director, discusses test results with H. S. Faram, quality control manager, Watervliet Paper Company, Watervliet, Michigan

"Over the years, we've found Wyandotte Chemicals an excellent source of supply"

—R. T. Trelfa, Watervliet Paper Company

Papermaking is a two-phase job. You have to produce a top-quality stock, within practical bounds of cost, to insure saleability. And, equally important, you must be on the lookout for new ideas and methods to keep pace with progress.

The operations of the Watervliet Paper Company, Watervliet, Michigan, are a good example of modern papermaking efficiency. Quality is controlled every step of the way. This, of course, includes the quality of materials purchased, like Wyandotte Caustic and Chlorine. They use caustic in treating waste paper; chlorine is needed in pulpmaking and bacteria control.

With an eye to the future, Watervliet has established the country's first mill to produce a fully bleached, neutral sulphite, semi-chemical pulp from hardwood. Furthermore, they have pursued an active course of co-operation with Wyandotte's research. Some of the joint activities have been detailed engineering on soda-based hypochlorites, and the application of fine calcium carbonates to paper finishes.

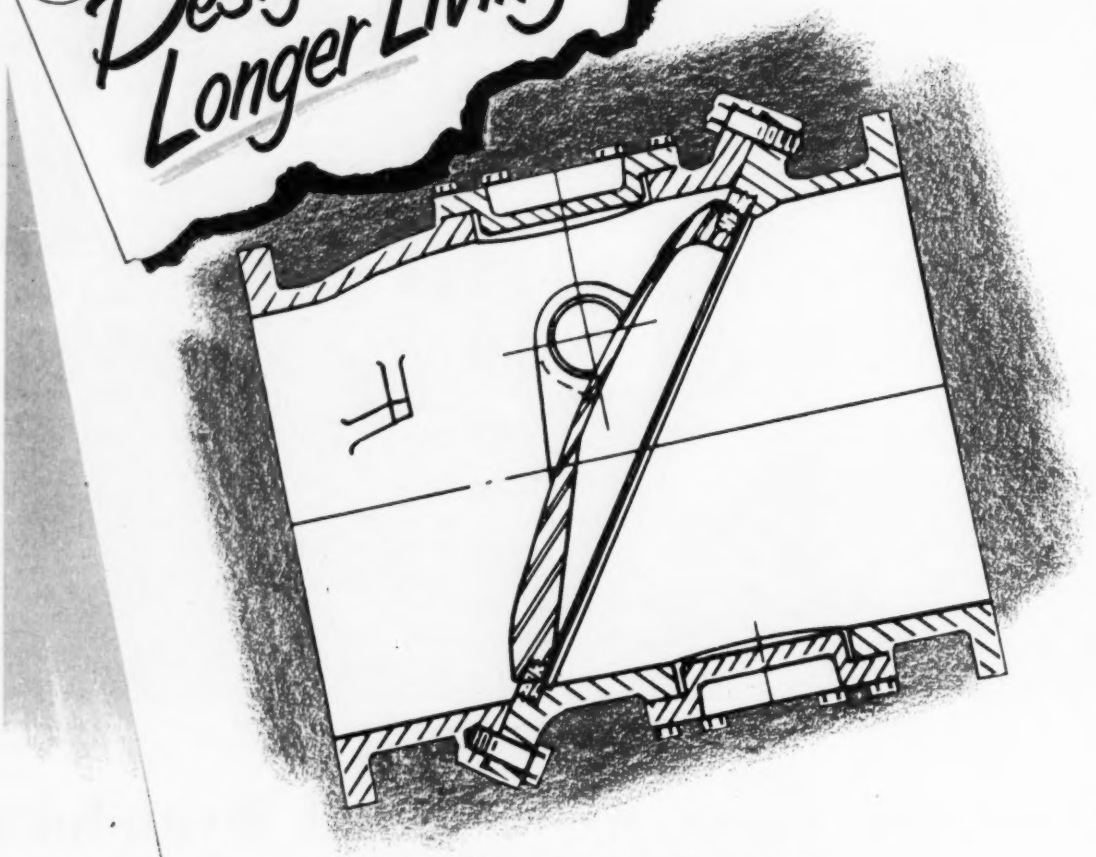
Commenting on Wyandotte products and service, R. T. Trelfa, Watervliet's technical director, says, "Over the years, we've found Wyandotte an excellent source of supply from the standpoint of both product quality and dependability of service."

If you use alkalies, chlorine, wetting agents, solvents, fumigants, insecticides or other chemicals, contact Wyandotte for either product data or technical service. You will find Wyandotte large enough to care for your needs, yet not too large to be interested in your day-to-day problems. Tell us your requirements . . . we may have a chemical that will satisfy your needs, or will work with you in developing a new one. May we serve you. *Wyandotte Chemicals Corporation, Wyandotte, Michigan. Offices in principal cities.*

Wyandotte
CHEMICALS
HEADQUARTERS FOR ALKALIES

Soda Ash • Caustic Soda • Bicarbonate of Soda • Chlorine
Calcium Carbonate • Calcium Chloride • Glycols • Synthetic Detergents • Agricultural Insecticides • Soil Conditioners
Other Organic and Inorganic Chemicals

Design for Longer Living



...You find it only in

CHAPMAN'S

Tilting Disc CHECK VALVE

Here you can see the specially designed *airfoil section* of the disc in the Chapman Tilting Disc Check Valve . . . and you can see how the disc-seat lifts away from the body seat when opening (and drops into contact when closing) with no *sliding or wearing of the seats.*

Under usual piping arrangements this unique designed disc won't slam . . . just cushions itself to a quiet closing that does not even jar the line.

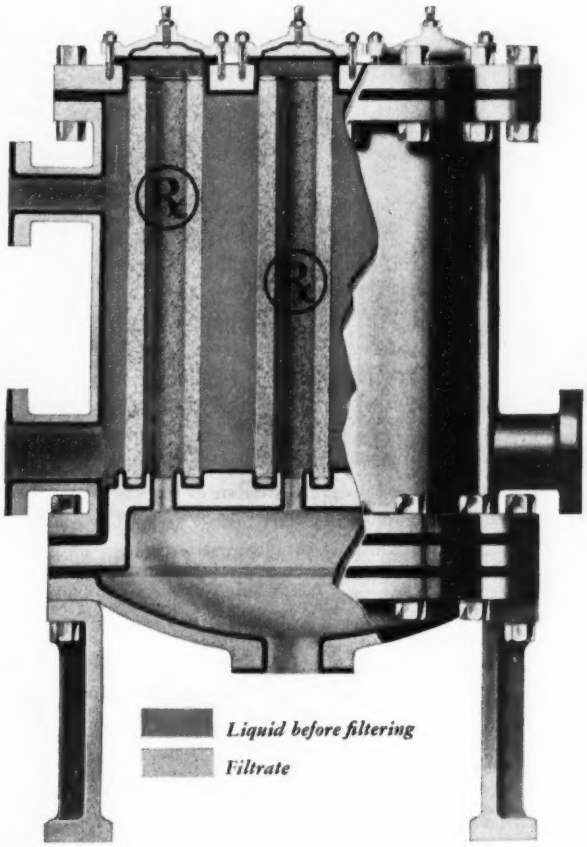
And this balancing is the reason why Chapman Tilting Disc Check Valves greatly reduce head-loss over standard designed swing-type checks . . . as proven by tests in leading engineering schools and by actual performance in the field.

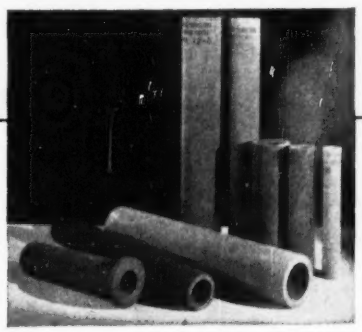
Available in iron or steel. Complete test data is given in Catalog No. 30–write for your copy now.

The Chapman Valve Mfg. Co.
INDIAN ORCHARD, MASSACHUSETTS

Another Norton Rx *on the job!*

Outstanding performance of Adams filters aided by Norton seamless porous tubes





R. P. Adams Co. Filters, covering many chemical filtering services, deliver sparkling clear filtrate and insure quick cleaning without disassembly. Adams filters handling acid or neutral solutions are equipped with Norton seamless porous tubes, *engineered and prescribed* for faster, more thorough filtering and backwashing.

Besides assuring fast, thorough filtering action, Norton porous tubes are extremely easy to clean by backwashing. Here are several good reasons why they excel in these two primary essentials of efficient, economical filter performance:

- Norton porous tubes are made of ALUNDUM* (fused alumina) *engineered* by Norton for chemical stability, inertness and other properties necessary to withstand acid, neutral and slightly alkaline liquors.
- Like all Norton ALUNDUM porous mediums they are made with the patented *controlled structure* process that assures even distribution of pores — for uniform passage of both filtering and backwashing liquids.
- They are *seamless,* providing unobstructed diffusion over their entire area — for further efficiency in both filtering and cleaning.

Other big advantages

of all Norton porous mediums include ease of installation and exceptional resistance to breakage and chipping. Available in sizes and open-pore ratios to meet your needs, they're *engineered* to last longer and cut your operating costs — and they're *prescribed* for a wide variety of chemical services, such as filtering water or solvents . . . cutting oils, wine, etc. . . . reclaiming cleaning fluids and industrial waste . . . and for boiler feed water treatment.

See your Norton Representative for further facts or write, describing your requirements, to NORTON COMPANY, 505 New Bond St., Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

NORTON

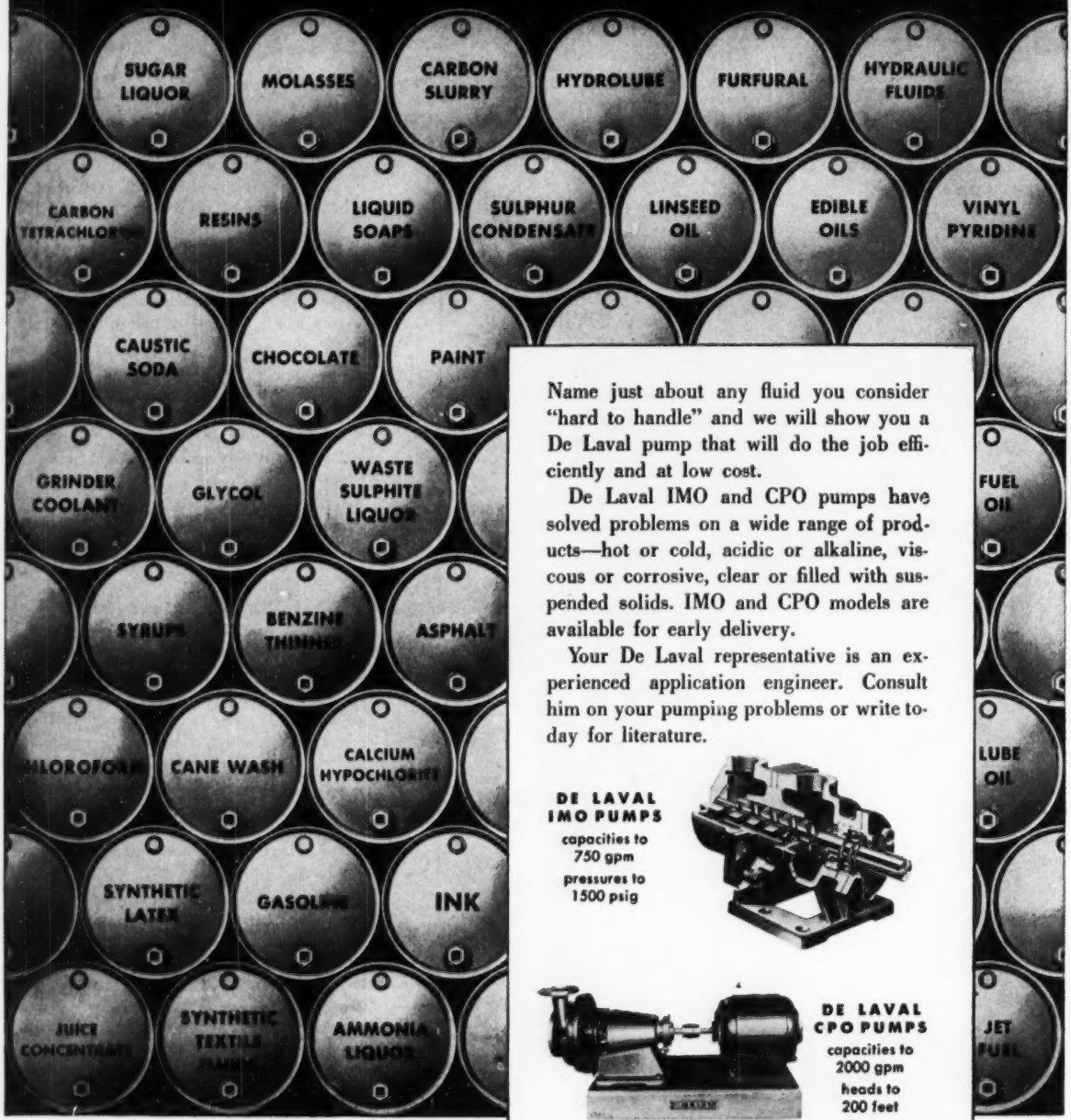
REFRACTORIES

Engineered . . . Rx . . . Prescribed

Making better products . . . to make other products better

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

Which of these is your pumping problem?



Name just about any fluid you consider "hard to handle" and we will show you a De Laval pump that will do the job efficiently and at low cost.

De Laval IMO and CPO pumps have solved problems on a wide range of products—hot or cold, acidic or alkaline, viscous or corrosive, clear or filled with suspended solids. IMO and CPO models are available for early delivery.

Your De Laval representative is an experienced application engineer. Consult him on your pumping problems or write today for literature.

DE LAVAL IMO PUMPS
capacities to 750 gpm
pressures to 1500 psig

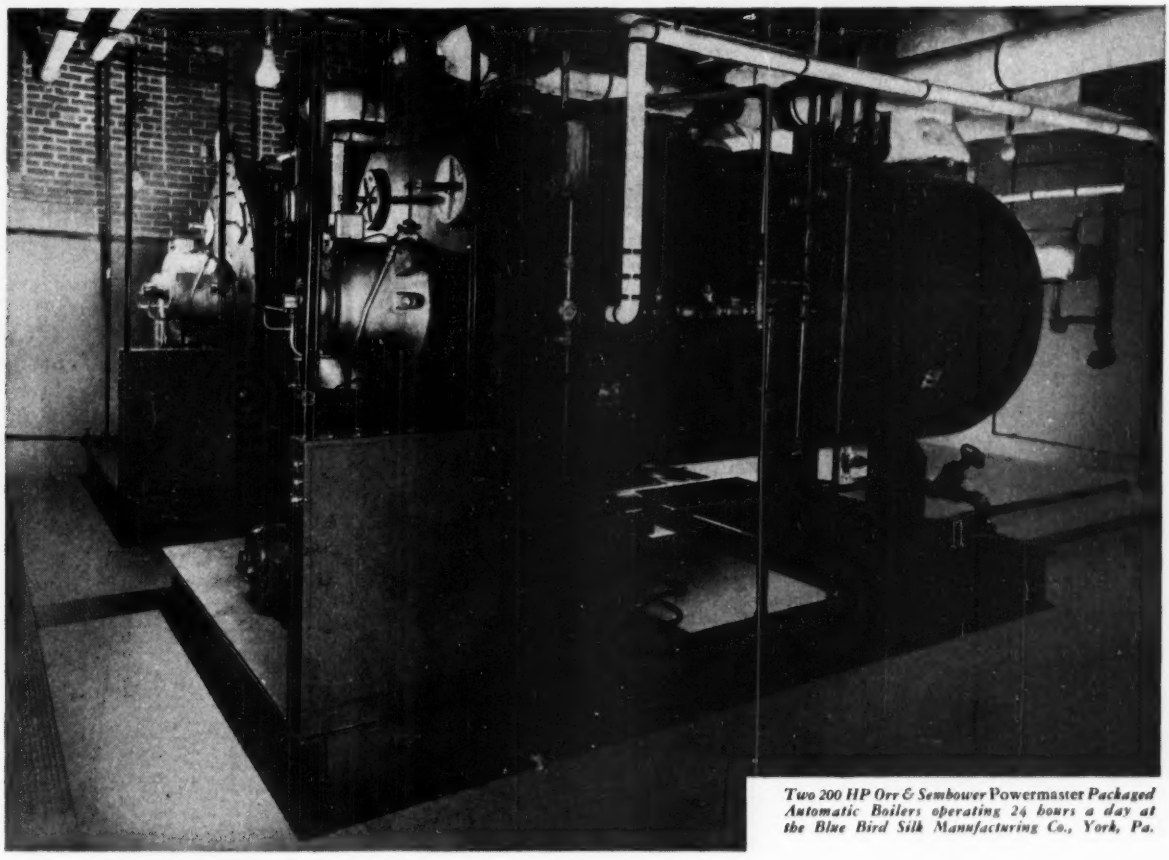
DE LAVAL CPO PUMPS
capacities to 2000 gpm
heads to 200 feet

DE LAVAL *Pumps*

DE LAVAL STEAM TURBINE COMPANY
803 Nottingham Way, Trenton 2, New Jersey

DL 330

IN TEXTILE MILLS...



Two 200 HP Orr & Sembower Powermaster *Packaged Automatic Boilers operating 24 hours a day at the Blue Bird Silk Manufacturing Co., York, Pa.*

Powermaster® Performance Pays Off

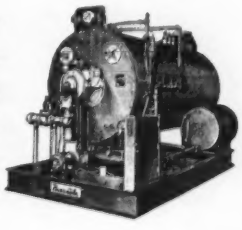
STEAM COSTS DOWN 20%—negligible maintenance. That's the two-year performance record of these two *Powermaster* Packaged Automatic Boilers operating round-the-clock at the Blue Bird Silk Manufacturing Company, York, Pa.

In addition to the cost-saving advantages, these units provide dryer, higher quality steam for processing and heating than the coal-fired boiler they replaced. Burning No. 6 Bunker C oil, they produce 13,800 pounds of steam per hour. And *Powermaster's* Voriflow burner design assures top straight line efficiency when operating between 30% and 100% of capacity.

Check these reasons why *Powermaster* is today's best buy for textile mills, schools, hospitals, industrial plants and all types of buildings: Cost-saving installation, space-saving compactness, dependability, fast steaming, hospital-clean operation, maintenance-saving accessibility, fully automatic operating and safety controls and smokeless combustion.

Find out why satisfied users all over America are saying, "Steam costs go down where *Powermasters* go in". Send for latest descriptive bulletin.

O·S *Powermaster*®
PACKAGED AUTOMATIC BOILERS
In sizes to 500 HP; pressures to 250 psi.



ORR & SEMBOWER, INC. • Established 1885 • **Morgantown Road, Reading, Penna.**

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters
INLET PORT
DISCHARGE PORT
DISCHARGE
DISCHARGE PORT
INLET PORT

Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

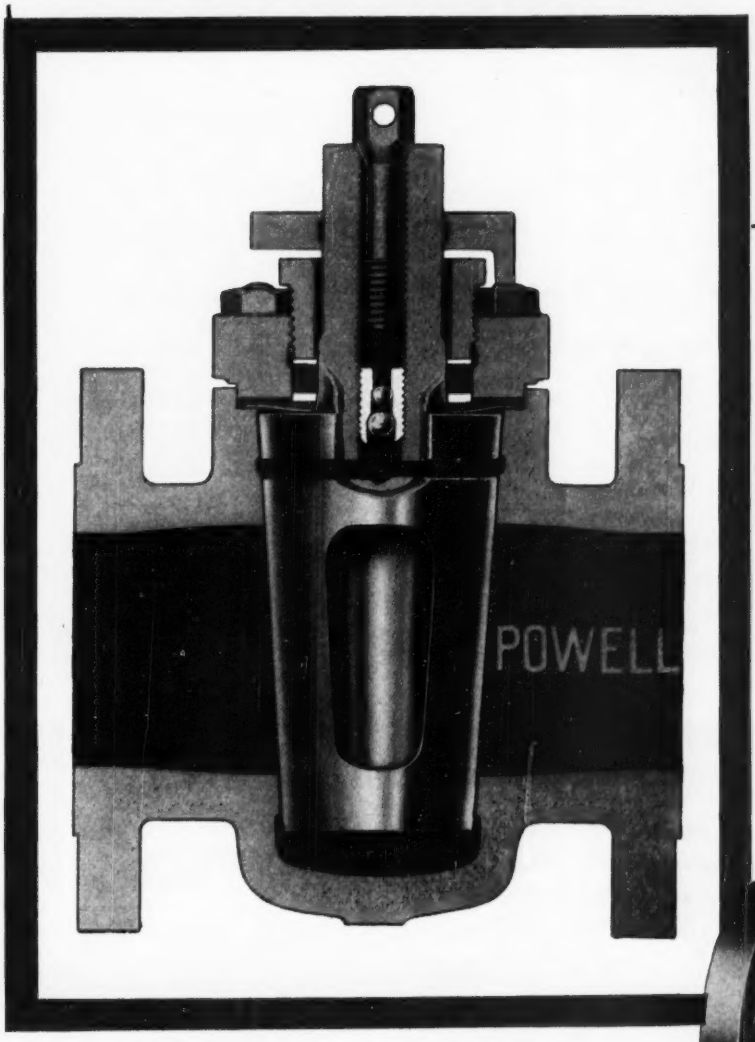
®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
395 WILSON, SO. NORWALK, CONN.

Powell LUBRICATED PLUG Valves

Now! A great new line of valves that maintain the Powell standards of precision!



Investigate these outstanding new Lubricated Plug Valves that carry the Powell name and measure up to the Powell standards of precision. Features include quick and positive operation – just a quarter-turn to open or close. Lubricant grooves surrounding each port provide a positive seal when the valve is closed. In an open position, seating surfaces are not exposed.

Available in Semi-Steel and Carbon Steel through distributors in principal cities. For descriptive literature–or help on valve problems–write direct to The Wm. Powell Company, Cincinnati 22, O.

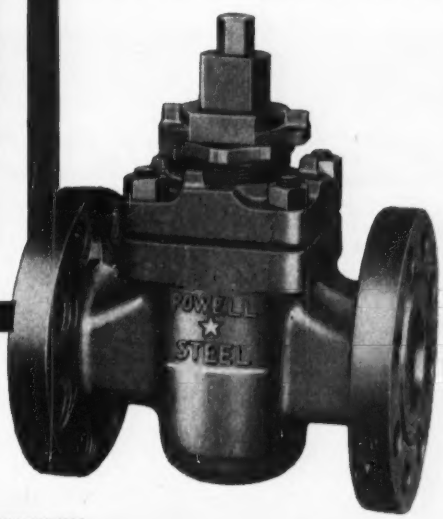


FIG. 1559 — 150-POUND STEEL FLANGED END LUBRICATED PLUG VALVE. *(300-pound Steel, Fig. 3059.)* Available with Screwed or Bolted Glands. Semi-Steel valves available for 175 and 200 pounds W.O.G. Carbon Steel valves available for 150 and 300 pounds W.P.

CONTROLS FOR THE LIFE LINES OF INDUSTRY

Powell Valves 108th year

In this electrolytic application

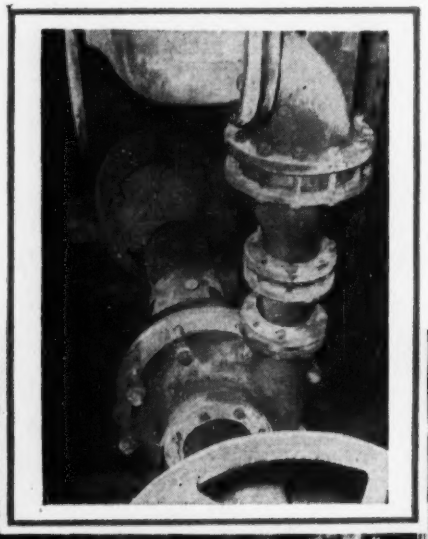
WILFLEY ACID PUMPS

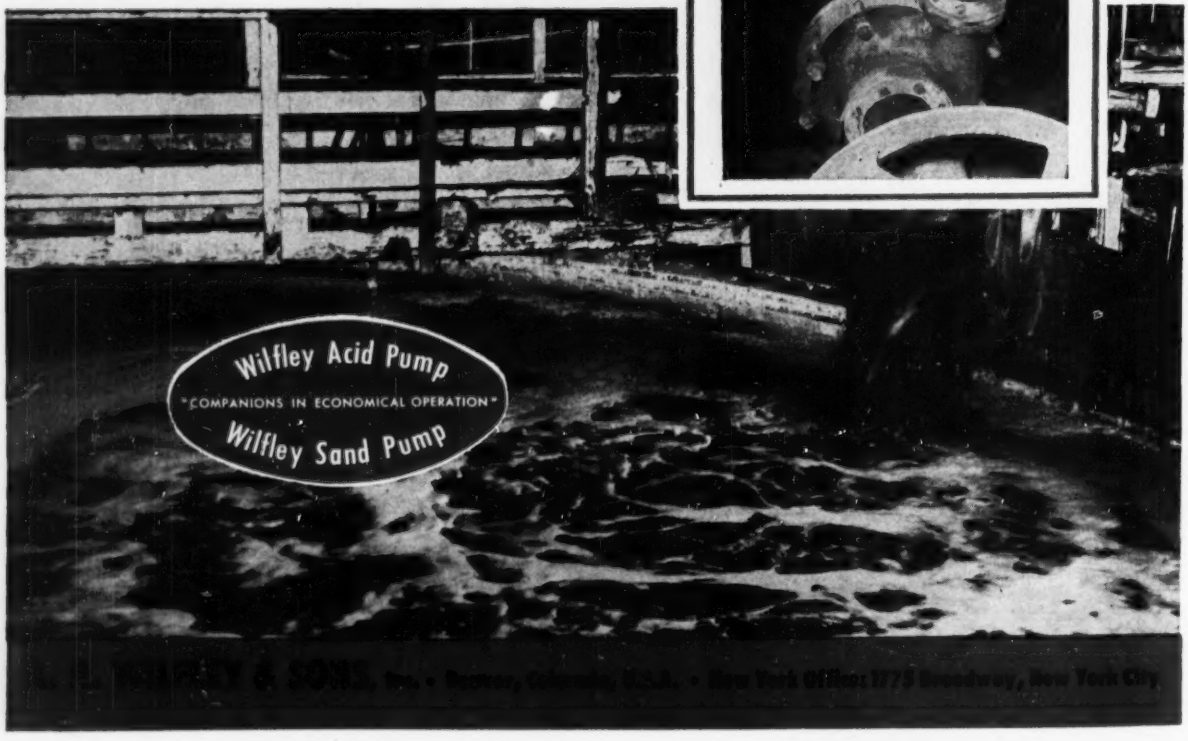
Reduce Costs and Increase Production

Wherever you find Wilfley Acid Pumps you find consistent cost-saving performance—especially on difficult pumping jobs. Continuous, trouble-free operation 24 hours a day without attention. Individual engineering on every application.

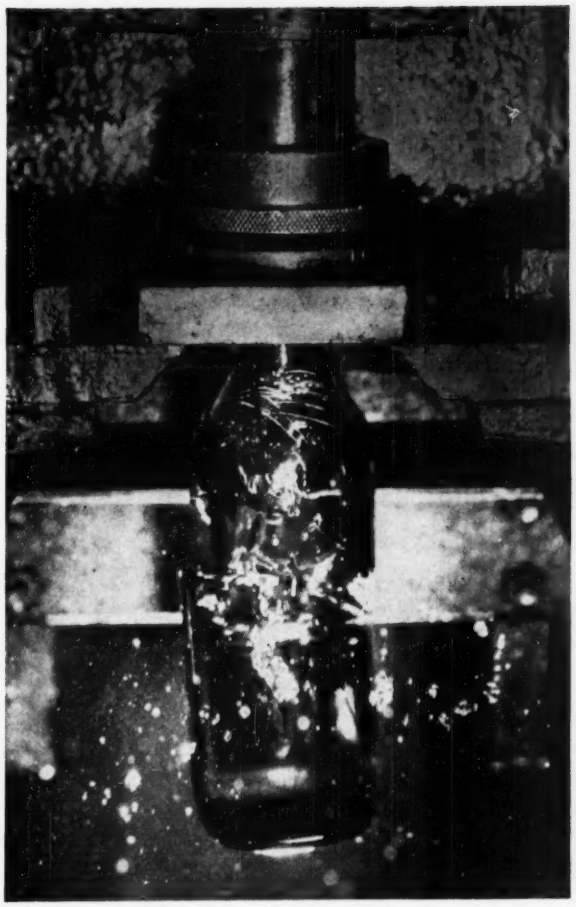
- **10- to 2,000-G.P.M. capacity; 15- to 150-ft. heads and higher.**
- **Wetted parts of all machinable alloys; plastic linings available.**

Write or wire for complete details.

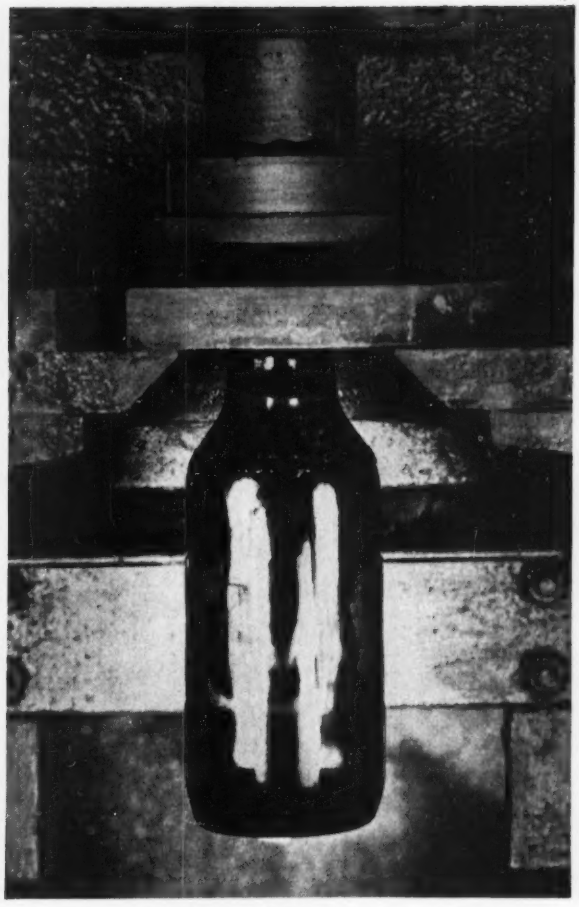




A. R. WILFLEY & SONS, Inc. • Denver, Colorado, U.S.A. • New York Office: 1775 Broadway, New York City



Untreated bottle soon bursts in hydrostatic testing machine.



Bottle treated with "Virginia" SO_2 resists premature shattering.

"VIRGINIA" SO_2 REDUCES BREAKAGE IN GLASS MANUFACTURE

Maybe it can solve a production problem for you, too

Our chemists discovered that small quantities of our inexpensive Liquid Sulphur Dioxide (SO_2)—introduced into the cooling lehr as a reducing agent—put a protective coat on bottles and other glass products. This resists scratching and increases bursting strength up to 40 percent. Substantial savings can be realized by using thinner glass.

Perhaps this cost-cutting application of "Virginia" SO_2 suggests a parallel situation in your plant. You never know until you try. In any case, if you think you might have a potential use for this versatile chemical, our research facilities are at your command in ferreting it out and our unequaled experience and engineering knowledge are yours for the asking.

This is the big bonus of *service* you get when you buy from "Virginia"—the world's largest producer of SO_2. If there is any chance whatever that there might be a profitable application of this low-cost chemical in your products or processes—as a reducing, bleaching or neutralizing agent, preservative, anti-chlor or *p*H control—get in touch with us promptly. Our experts will call to discuss the matter without obligation. Chances are ten to one their experience can save you money.

Industrial Department
VIRGINIA SMELTING COMPANY
Box 21, West Norfolk, Virginia

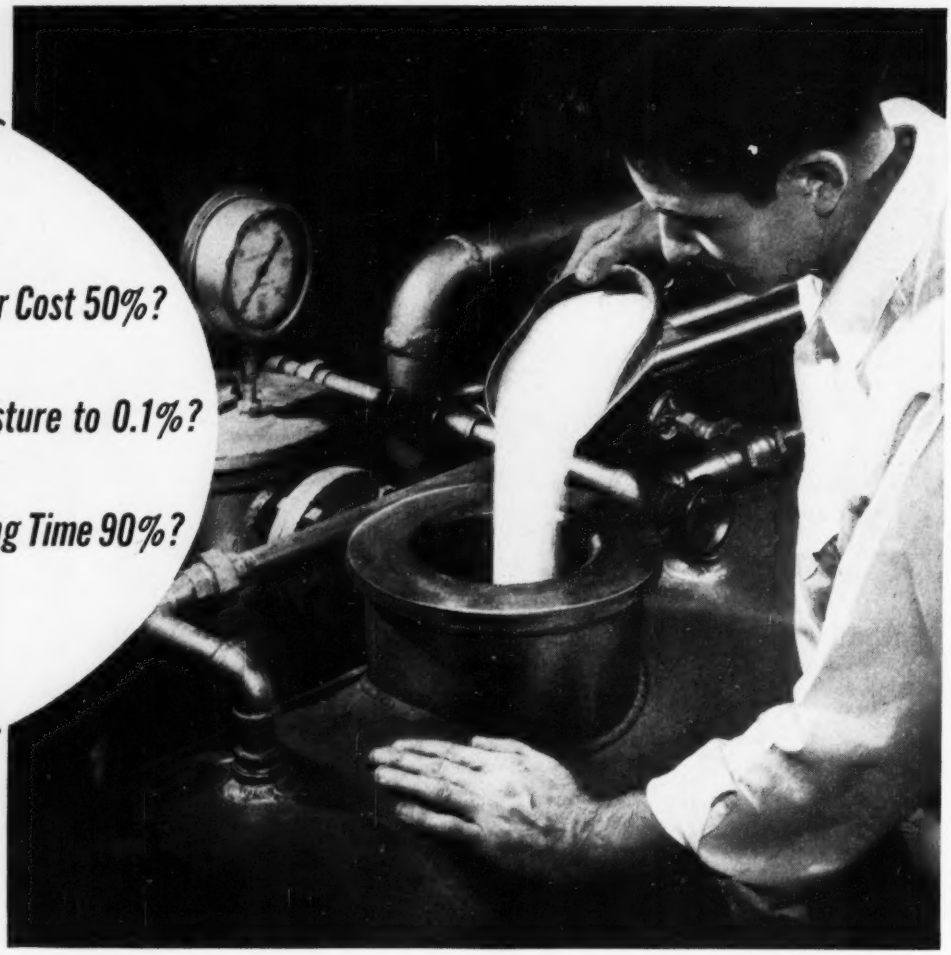
VIRGINIA Chemicals

Field Offices: NEW YORK • BOSTON • DETROIT
CHICAGO • ATLANTA • ASHEVILLE
Available in Canada and many other countries

What Cuts Labor Cost 50%?

What Cuts Moisture to 0.1%?

What Cuts Drying Time 90%?



Operator loads Rotary Vacuum Dryer in Stokes pilot plant.

Labor and time are reduced 50% by vacuum drying of a mixture of acetyl salicylic acid and other chemicals.

Sodium trichloracetate is reduced from 35% to 0.1% moisture content in 8 to 12 hours by vacuum drying.

Several makers of powdered aluminum and brass avert fire and explosion hazards by drying powders and solvents in vacuum . . . then recover 99% or more of the solvent in the same process.

Shellac is dried in vacuum in 6 to 8 hours per batch, a job that formerly took 72 hours!

Stokes has the laboratory and pilot plant facilities to test vacuum drying of any product which offers drying difficulties. Methods, cycles, equipment, costs will be accurately determined. Stokes has 40 years' experience in vacuum technology to share with you on drying problems.

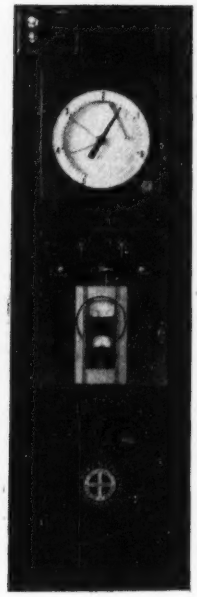
Send for an informative brochure, "Vacuum Drying," on the techniques of moisture removal from chemicals, pharmaceuticals and other industrial products.

F. J. STOKES MACHINE COMPANY
PHILADELPHIA 20, PA.

STOKES

STOKES MAKES: High Vacuum Equipment, Vacuum Pumps and Gages / Industrial Tabletting, Powder Metal and Plastics Molding Presses / Pharmaceutical Equipment

M·S·A PROCESS CONTROL INSTRUMENTS



M·S·A OXYGEN INDICATOR (TYPE C-2)

Designed to continuously measure the oxygen content of industrial atmospheres, this compact, accurate instrument provides a means for improving safety in utility operations, effecting economies as a measure of combustion efficiency, and aiding in the control of pipe line corrosion. To accommodate all applications, the instrument is available in the following scale ranges: 0 to 1.0%, 0 to 5.0%, 0 to 10%, and 0 to 25%.

APPLICATIONS:

- **Hydrogenation Processes**
  0 to 1% Oxygen in Hydrogen
- **Fluid Catalytic Cracking**
  0 to 1% Oxygen in Regenerator Flue Gases
- **Inert Gas Control**
  0 to 1% Oxygen in Inert Gases
- **Combustion Control**
  0 to 1% Oxygen in Flue Gases

Write today for our bulletins, or send along your problem

M·S·A INFRA-RED GAS AND LIQUID ANALYZER (LIRA)

For automatic analysis of fluid mixtures, measurement of toxic contaminants in air, precise process control. This device makes a continuous analysis of one component of a mixture. It is extremely stable and accurate which makes it an ideal unit for production control and research problems.

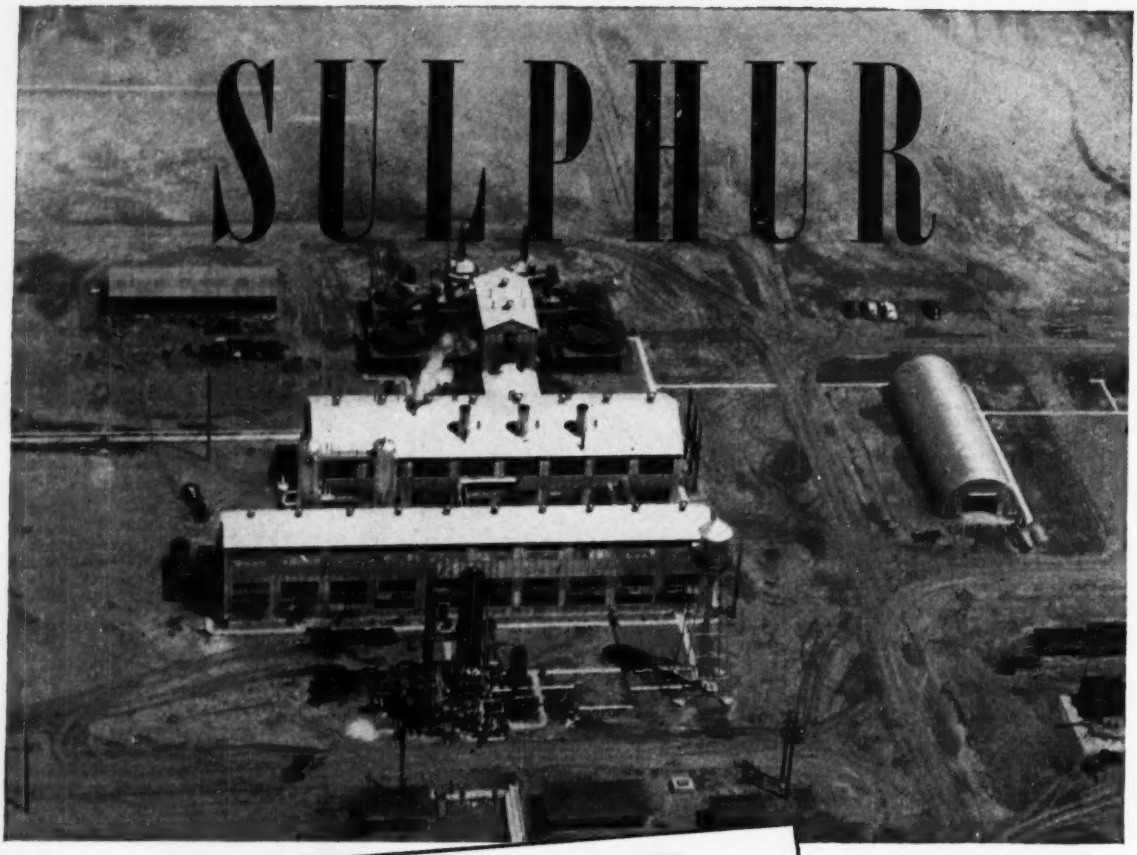
APPLICATIONS:

- **Ammonia Synthesis**
  Carbon Monoxide—0–5 ppm at 200 psi;
  0–100 ppm at atmospheric pressure
  Carbon Dioxide—0–2 ppm at 200 psi;
  0–50 ppm at atmospheric pressure
- **Ethylene Product**
  Ethylene 95–100%
- **Ethylene Purity**
  Acetylene—0–200 ppm; Ethane—0–½%;
  Methane—0–½%
- **Product Loss Control**
  Propane—0–2% in Hydrocarbon Stream
  Ethylene—0–5% in Hydrocarbon Stream

SAFETY EQUIPMENT HEADQUARTERS

Call the M.S.A. man on your every safety problem . . . his job is to help you

MINE SAFETY APPLIANCES COMPANY
201 North Braddock Avenue, Pittsburgh 8, Pa.
At Your Service: 76 Branch Offices in the United States
MINE SAFETY APPLIANCES CO. OF CANADA, LTD.
Toronto, Montreal, Calgary, Edmonton, Winnipeg, Vancouver, Sydney, N.S. • Representatives in Principal Cities in Mexico, Central and South America
Cable Address: "MINSAF" Pittsburgh



Sour Gas (H_2S) Sulphur Recovery Plant, Worland, Wyoming.

Sour Gas...

...an increasingly important source

The largest elemental sulphur producing area in the world today is a narrow belt along the Coast of the Gulf of Mexico. Large quantities of elemental sulphur lie in natural beds in Japan, Italy, the Andes Mountains of South America, as well as many other sections of the world.

Most of the natural gas coming from fields on the East slope of the Rocky Mountains contains hydrogen sulphide rendering the gas "sour." The recovery of the sulphur from this gas, thereby purifying it, is a feat of chemical engineering.

Both metallurgy and chemistry combine in Canada, Norway, Sweden, Spain, Portugal, Germany, Great Britain, Holland and Egypt to produce substantial quantities of elemental sulphur from sulphides of hydrogen, iron and oil shale.

This company has the largest single unit in the world at Worland, Wyoming, recovering elemental sulphur from hydrogen sulphide contained in sour gas.

Texas Gulf Sulphur Co.

75 East 45th Street, New York 17, N. Y.

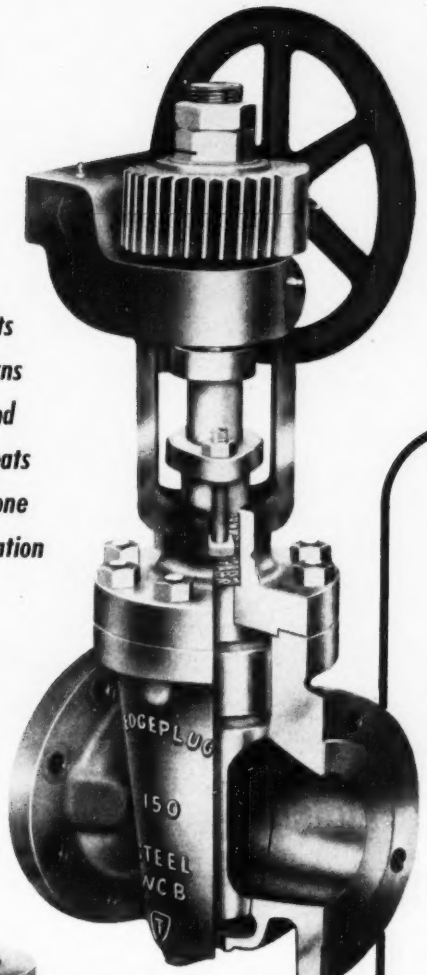
Sulphur Producing Units

- **NEWGULF, TEXAS**
- **MOSS BLUFF, TEXAS**
- **SPINDLETOP, TEXAS**
- **WORLAND, WYOMING**

for general service...

WEDGEPLUG
STEEL DRY PLUG VALVES

lifts turns and reseats in one operation



for special service...

WITH COATED PLUG

Wedgeplug Steel Valves, equipped with our Special-Coated Plug, are setting new standards for valve performance. The Special Coating, which is bonded to the metal, assures a tight seal, and is highly resistant to abrasion and corrosion. Ideal for handling Petroleum Oils, Liquefied Petroleum Gases, Gasoline, Kerosene, Air, Gas, Water, Vegetable Oils, Animal Fats, Alcohols, Turpentine, Acid Solutions, Alkaline Solutions, Saturated Salt Solutions, and many Solvents and Chemicals. . . . Recommended for operating temperatures between —40° and +200° F.

Available from Stock, with *Hycar-Coated Plug

MADE IN THREE TYPES: WRENCH-OPERATED HANDWHEEL-OPERATED • GEAR-OPERATED

*Hycar is the trade-name of the Product, made by B. F. Goodrich Chemical Co., used in coating Plug.

WEDGEPLUG VALVE COMPANY, INC.
NEW ORLEANS 15, LA.

An Affiliate of

STOCKHAM VALVES & FITTINGS
GENERAL OFFICES AND PLANT • BIRMINGHAM 2, ALA.

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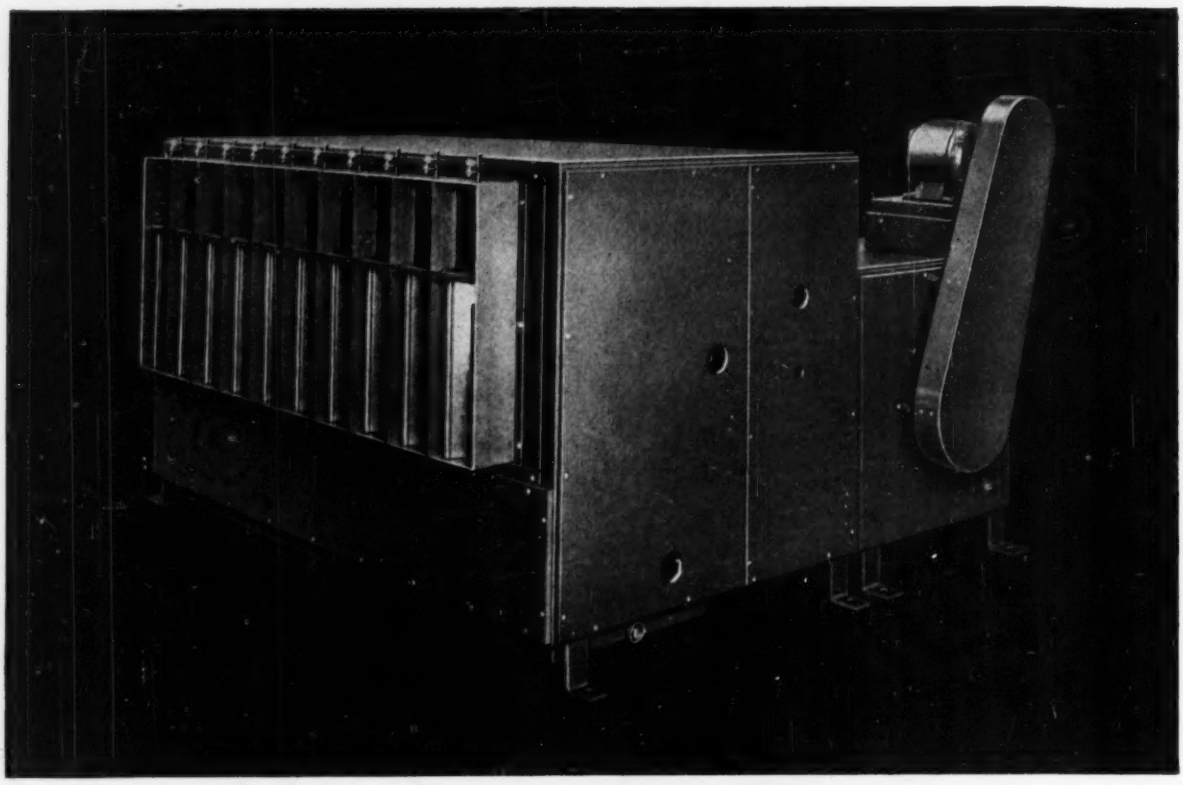
PITTSBURGH • ST. LOUIS • WASHINGTON • SAN FRANCISCO

Write for **WEDGEPLUG** *Catalog*

DISTRIBUTED THROUGH WHOLESALERS



Now...A Westinghouse Multi-Zone Unit Automatically Conditions Air— Up to 12 Independent Zone Areas

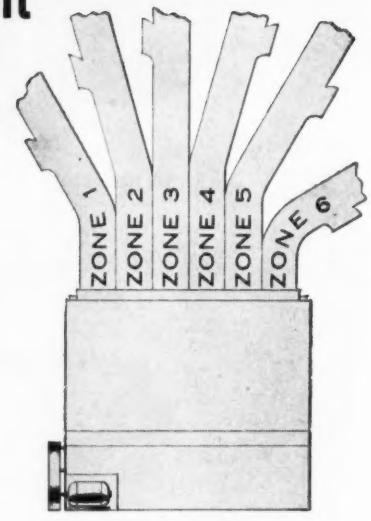
This rugged, compact central plant air conditioning unit supplies air, conditioned for simultaneous unequal heat load demands, in various zones requiring individual temperature and humidity control.

Formerly, heat load variations caused by differences in building construction, changes in occupancy, wind or solar exposure, could be controlled only by separate supply systems for each zone or by expensive zone reheat arrangements.

Now . . . this problem can be solved with a single Westinghouse Multi-Zone Air Conditioning Unit. Efficient . . . economical . . . this versatile unit supplies air—conditioned at a central location—for the individual needs of as many as 12 zones.

This complete unit—fans, coils, motors and starters—is designed and manufactured by Westinghouse, permitting a single equipment warranty with undivided responsibility . . . an exclusive feature in all Westinghouse Air Handling Units.

For complete information about this outstanding advance in central plant air conditioning, call your nearest Sturtevant Sales Engineer today. Or write: Westinghouse Electric Corporation, Sturtevant Division, Boston 36, Mass.



TOP VIEW
(FOR SIX ZONES)

Multi-Zone Units are of the blow-through type with divided outlets to serve multiple zones by supplying heated or cooled air, or controlled mixtures of both, to each zone.

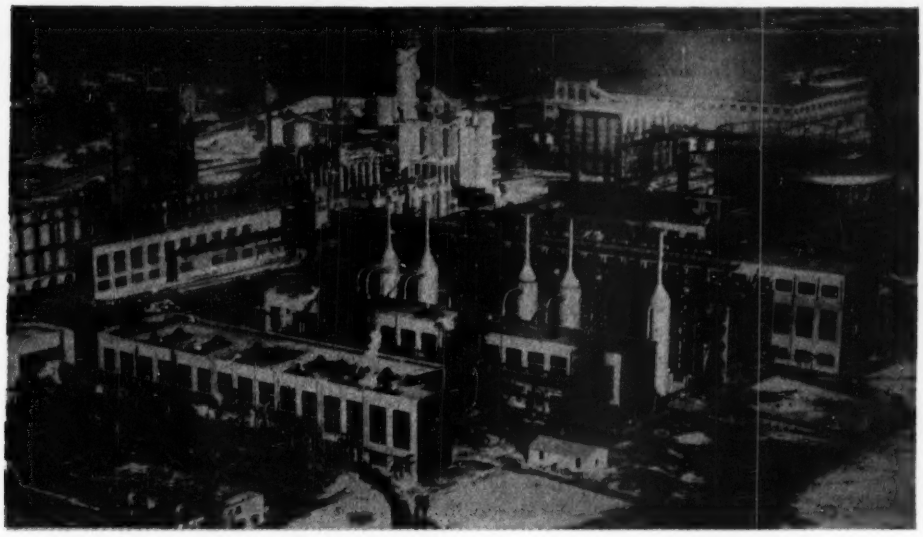
WESTINGHOUSE AIR HANDLING

YOU CAN BE SURE...IF IT'S Westinghouse

J-80393

IF YOU WANT PURITY,
YOU NATURALLY WANT

NITROGEN DIVISION
Anhydrous Ammonia



OUR HOPEWELL, VIRGINIA NITROGEN PLANT. WORLD'S LARGEST producer of Nitrogen and Ammonia Products, Nitrogen Division has spent over $50,000,000 since the war, improving service and building ultra-modern processing facilities.

The pioneer producer of high purity Anhydrous Ammonia, Nitrogen has an almost unlimited fund of skill and know-how that comes from 60 years' experience. This experience is at your command, ready to help you with Technical Service in the use and handling of Ammonia—with Technical Service Manuals—or with fast, dependable scheduled deliveries wherever your plant may be located.

If purity is important to you—and it is in most industries—why specify anything but the best... especially when the best costs no more?

(An interesting highlight: Our Hopewell, Va. plant was *America's chief source* of high purity Nitrogen during the war, while Government plants were being built.)

First In Ammonia Since 1890

NITROGEN DIVISION

ALLIED CHEMICAL & DYE CORPORATION

40 Rector Street, New York 6, N. Y.

Ammonia • Sodium Nitrate • Urea • Ethylene Oxide
Ethylene Glycol • Diethylene Glycol • Triethylene Glycol
Methanol • Formaldehyde • Nitrogen Tetroxide
U.F. Concentrate—85 • Nitrogen Solutions
Fertilizers & Feed Supplements

Anhydrous Ammonia
Refrigeration grade
Commercial grade

Ammonia Liquor

Cylinder Ammonia
Refrigeration grade

SHIPPING:
In tank cars from our producing plants at Hopewell, Va., South Point, Ohio and Omaha, Neb. In cylinders, fast delivery from 49 coast-to-coast distribution points!

NITROGEN DIVISION, ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

☐ Please have your specially trained Ammonia Technical Serviceman call to discuss the economical use, etc. of Anhydrous Ammonia. No obligation.

☐ Please send your valuable handbook "Guide to use of Barrett® Brand Cylinder Ammonia." (Shows most economical usage; contains chemical properties, handling, charts, etc.

☐ Please send your free Ammonia Leak Detector Kit. (Pocket size, this handy kit can be used over and over again.)

NAME & TITLE_____

COMPANY_____

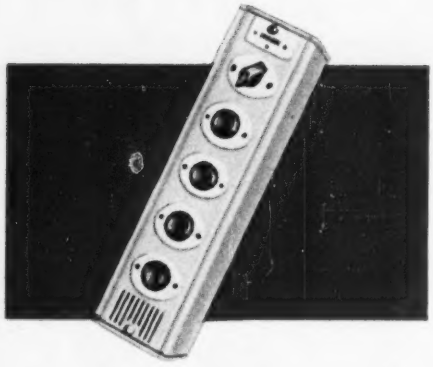
ADDRESS_____

CITY_____ STATE_____ CE-6

DIAL THE SPEED—CONTROL THE PROCESS

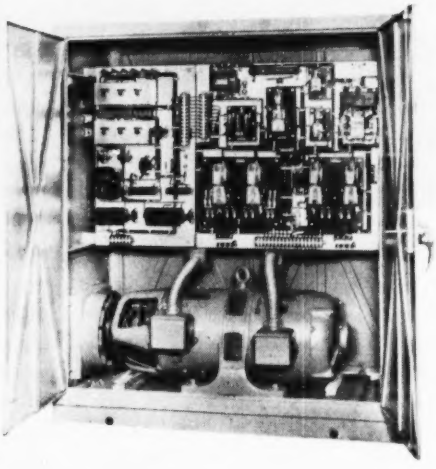
with a Performance Rated© Century SELECTIVE SPEED DRIVE

- **Offers automatic control integrated with your process.**
- **Covers a wide speed range—forward or reverse.**
- **Starts, stops—fast or slow.**
- **Allows forward or reverse jogs.**
- **Controls one or more motors.**



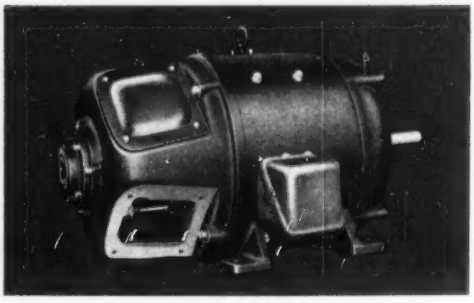
With a Century Performance Rated Selective Speed Drive, you can often integrate speed changes to cycle automatically as the process requirements dictate.

- You can automatically regulate metal cutting for optimum cutting speeds.
- Make the speed change automatically sensitive to changing temperature or pressure.
- Make the speed change automatically sensitive to changing diameter of a feed roll.
- Make the speed change automatically sensitive to the viscosity of a mix.
- You can use many different kinds of control devices in the control circuit to change speeds ... to jog ... to apply dynamic braking, etc.



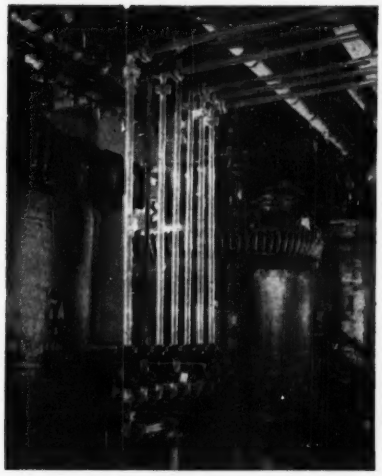
You're welcome to full information on your specific drive problem. Call your nearest Century District Sales Office or Century Authorized Distributor, or write direct. See telephone listings.

Century makes A. C. and D. C. motors
1/8 to 400 H. P.



Century C MOTORS

CENTURY ELECTRIC COMPANY
1806 Pine Street, St. Louis 3, Missouri
Offices and Stock Points in Principal Cities



Far Left: **PYREX brand "Double-Tough" Glass Pipe** ends replacement of corroded lines... simplifies cleaning . . . enables you to *see* what's happening inside the line.

Available in 1" to 6" I. D. with all standard fittings, as well as sink traps. Your plant personnel can handle PYREX pipe without special training.

For information and pictures, check the coupon below for "PYREX brand Glass Pipe in the Process Industries" (EA-1) and "PYREX brand 'Double-Tough' Glass Pipe and Fittings" (EA-3).

Left: **PYREX brand Fractionating Columns** give you unusual advantages in solving fractionating and absorption problems. No corrosion, no contamination. And you *see* flow, performance and condition of product.

Available in 4" and 6" sizes with any number of plates.

Standard packed columns are available in 4", 6", 12" and 18" inside diameter sizes. Can be packed with PYREX brand Glass Rachig Rings. Check the coupon for data sheet of helpful information and applications.

Have YOU a corrosion problem one of these glass products can cure?

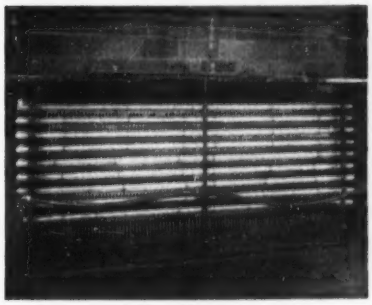
Corrosive liquids create special problems. Your pipes, coolers, and fractionating columns forever need attention, repairs or replacement. Product contamination is common. There's no fast, sure method of cleaning corroded equipment.

Why put up with these headaches when you can easily avoid them with PYREX brand glass equipment?

These are reasons why glass takes the headaches out of corrosive liquids:

1. *Glass does not rust* . . . It's unaffected by all *acidic* solutions and acids except hydrofluoric.
2. *Glass is non-contaminating* . . . The high chemical stability of PYREX brand glass equipment assures product purity.
3. *Glass is transparent* . . . You see what's happening as it happens. You have an immediate visual check on conditions within the equipment.
4. *Glass is easy to clean* . . . There's no place for deposits to build up on its hard, smooth surface.
5. *Glass is strong* . . . PYREX brand glass No. 7740, used for pipe, cascade coolers, and towers, has great physical and thermal shock resistance.
6. *Glass is economical* . . . Installation is simple. Maintenance is negligible. You will find the initial and maintenance costs of PYREX equipment low.

It will cost you nothing to find out if PYREX brand glass equipment can help you. And finding out may bring important savings. *Write, wire, or phone the nearest Corning plant equipment distributor listed below. Or mail the coupon.*



Above: **PYREX brand Cascade Coolers** give you low cost per BTU transferred, *plus* low cost operation. As many as 40 tubes can be stacked vertically in a single unit (20 tubes under one trough) to meet varied requirements. You can use cheap river or sea water as the coolant.

Check illustrated bulletin (PE-8) on the coupon for complete information on PYREX brand Cascade Coolers. It demonstrates why PYREX tubes provide high heat transfer.

DISTRIBUTOR LIST

BELMONT, CALIFORNIA	Glass Engineering Laboratories
FRESNO 17, CALIFORNIA	Valley Foundry & Machine Works
NEW HAVEN, CONNECTICUT	Macalaster Bicknell Company
ATLANTA, GEORGIA	Southern Scientific Company
CHICAGO 44, ILLINOIS	Fred S. Hickey, Inc.
NEW ORLEANS, LOUISIANA	W. H. Curtin & Company
CAMBRIDGE 39, MASS.	Macalaster Bicknell Company
ST. LOUIS 4, MISSOURI	Stemmerich Supply, Inc.
LODI, NEW JERSEY	Mooney Brothers Corporation
ALBANY 5, N. Y.	A. J. Eckert Industrial Sales Corporation
BUFFALO 13, N. Y.	Buffalo Apparatus Co.
ROCHESTER 3, N. Y.	Will Corporation
HATBORO, PA.	Sentinel Glass Company
PITTSBURGH 19, PA.	Fisher Scientific Company
HOUSTON 7, TEXAS	W. H. Curtin & Company
SEATTLE 4, WASHINGTON	Scientific Supplies
TORONTO, ONTARIO, CAN.	Fisher Scientific Company, Ltd.
MONTREAL 3, QUEBEC, CAN.	Fisher Scientific Company, Ltd.
VANCOUVER, B. C., CAN.	Scientific Supplies

Corning means research in Glass

PYREX

CORNING GLASS WORKS

16 Crystal Street, Corning, N. Y.

Please send me the material checked below:

"PYREX brand 'Double-Tough' Glass Pipe and Fittings Catalog" (EA-3) ☐

"PYREX brand Glass Pipe in the Process Industries" (EA-1) ☐

"PYREX brand Cascade Cooler Bulletin" (PE-8) ☐

Data sheet on Fractionating Columns ☐

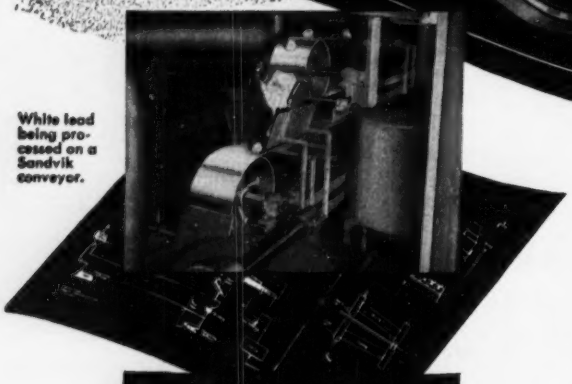
Name..... Title.....

Company.....

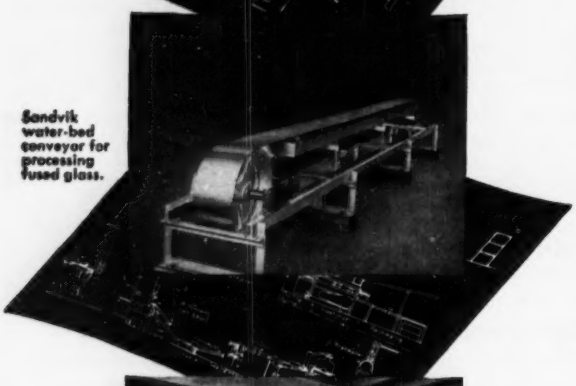
Address.....

City..... Zone..... State.....

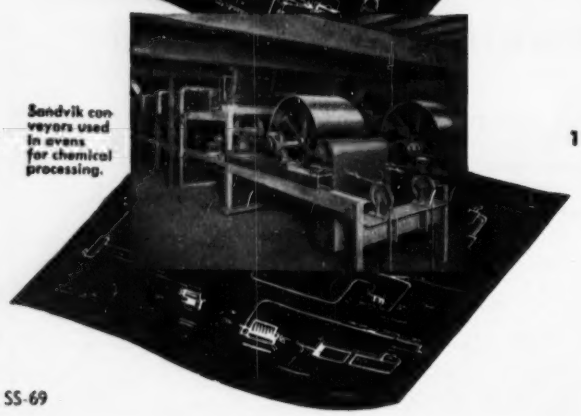
A SANDVIK STEEL-BELT CONVEYOR
may belong in YOUR plan FOR BETTER PROCESSING



White lead being processed on a Sandvik conveyor.



Sandvik water-bed conveyor for processing fused glass.



Sandvik conveyors used in ovens for chemical processing.

SS-69

Sandvik conveyors, designed for specific jobs, have opened the door to faster, better processing in plant after plant. Perhaps a Sandvik unit can do the same for you.

BASIC ADVANTAGES — Sandvik conveyors have a solid band of flat, stainless or carbon steel. The band provides a smooth, hard, impervious surface that is easy to keep clean. It has a high load capacity and a long service life. It can be fitted with simple discharge devices that scrape material off at any point. It can be used to convey materials through ovens. Belts can be of any length or width.

COOLING ARRANGEMENT — Sandvik conveyors can be built with a patented water-bed arrangement which cools from beneath . . . no water gets on top of the band. You can cool and convey, regulate thickness while cooling, cool and strip off gelatinous materials in sheet form, cool loose and pulverized materials, cool solids in sheet form and cool materials in layers.

ENGINEERING HELP — Sandvik's engineering department will be glad to help you determine where and how a Sandvik conveyor can improve your processing. Sandvik builds complete conveyors to fit the job.

SANDVIK STEEL BELT CONVEYORS
Division of Sandvik Steel, Inc.
111 Eighth Avenue, New York 11, N. Y. • WAtkins 9-7180
Branch Office: 230 N. Michigan Avenue, Chicago 1, Ill. FRanklin 2-5638
IN CANADA: SANDVIK CANADIAN LTD., 5675 Royalmount Ave., Montreal 16, P.Q.

SANDVIK STEEL BELT CONVEYORS

because REYNOLDS ALUMINA TRIHYDRATES are Organic Free

Whiter than white . . . purer than pure! That's probably stretching the point. But leading alum producers have found the whiteness and purity of Reynolds Alumina Trihydrates enhances the quality of their product . . . and reduces manufacturing costs.

Available only from Reynolds, these premium chemicals sell for standard prices. They also eliminate bleaching, cut foaming and chlorate contamination, will not cause color streaking.

Reynolds Organic Free Alumina Trihydrates can help improve your products and reduce costs. For full details call your nearby Reynolds office listed under "Aluminum" in the classified telephone directory, or write Reynolds Metals Company, 2567 South Third St., Louisville 1, Ky.

Write for free brochure on "Reynolds Aluminum Chemicals" to the address above.

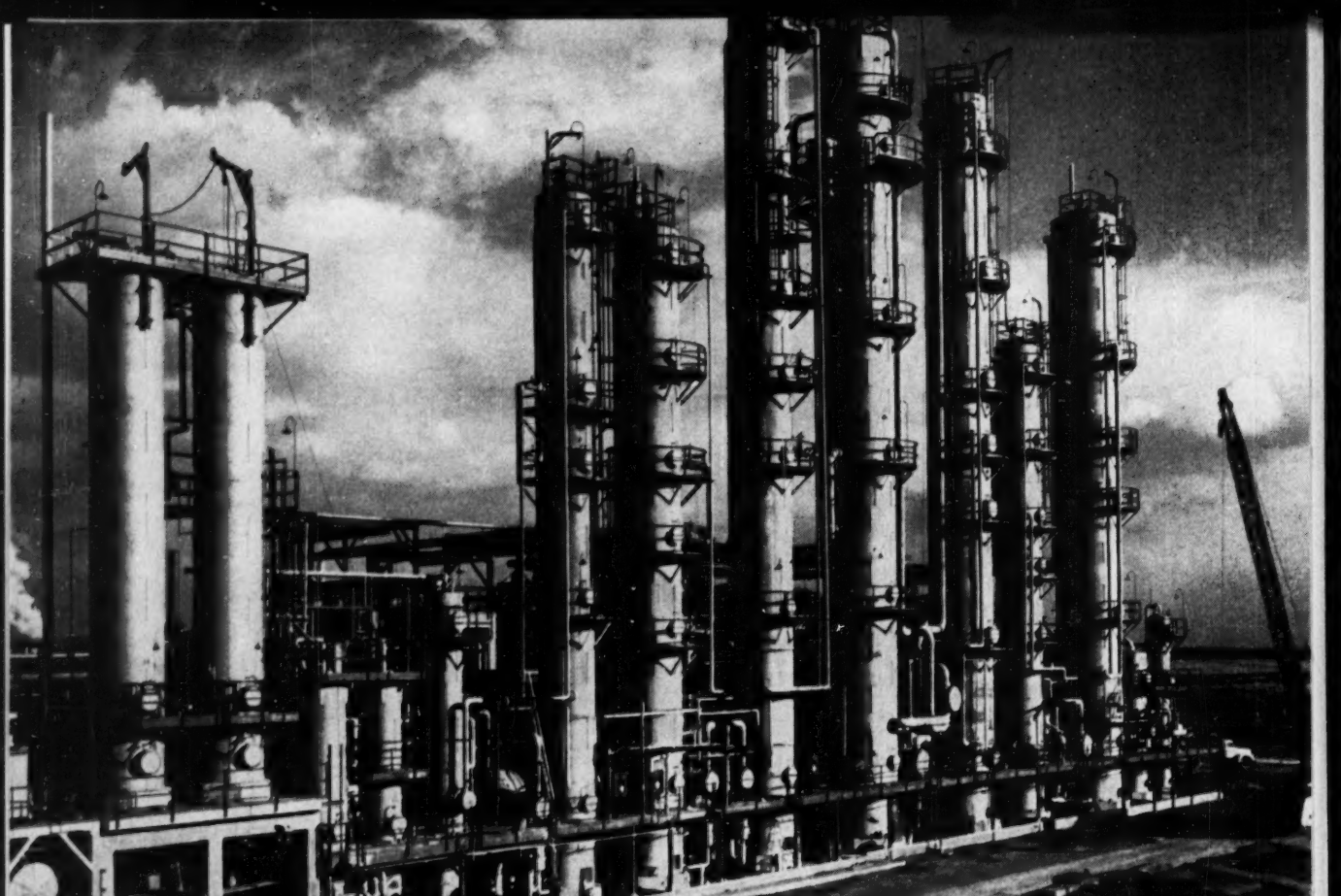
Put Reynolds Consulting Service to Work for You

The staff of each Reynolds regional office includes chemical and other engineering specialists to help you save time, money and labor with aluminum chemicals, shipping containers and mill products. When further consultation is desired, there is a fully integrated technical staff at Reynolds headquarters.

See "Mister Peepers" Sundays on NBC-TV. Consult local listings for time and station.

REYNOLDS CHEMICALS

FROM THE PRODUCERS OF REYNOLDS ALUMINUM



SUN OIL'S PETROCHEMICAL PLANT

now making high-purity aromatics

NITRATION **BENZENE**

NITRATION **TOLUENE**

10 DEGREE **XYLENE**

The new $15 million Sun Oil Company petrochemical plant in Marcus Hook, Pa., can now supply benzene, toluene and xylene that meet a new high standard of purity. It is the largest and most modern plant on the East Coast producing these aromatics from petroleum.

Precision instrumentation, combined with the most modern available facilities, provides constant control of every step in the refining process. Only selected feed stocks are used. The result is month-in, month-out sameness—even with high volume throughput—plus new versatility and efficiency.

Other petrochemicals produced by Sun Oil Company include propylene trimer and tetramer, sulfonates, and a new type of high-molecular-weight naphthenic acid that is practically free of oil. For a technical bulletin describing any of these Sun petrochemicals, write Department CE-6,

INDUSTRIAL PRODUCTS DEPARTMENT

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NO BOILER HAS EVER OFFERED SO MANY ADVANTAGES AND QUALITY FEATURES AT SUCH LOW INITIAL COST

• This NEW CB boiler has EVERYTHING needed to bring *big boiler standards* to commercial, industrial and institutional users with small capacity requirements. Despite its unusual, compact size you get big boiler performance — from matched-quality components, proved the world over on thousands of Cleaver-Brooks self-contained units.

Get all the facts NOW on how the new CB can help you save dollars. Make it a point to see . . . and *hear* the most silent-running, biggest boiler value available anywhere!

gives you all the quality features of time-tested self-contained design

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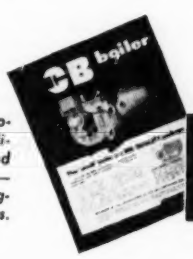
- **FULLY APPROVED** — by Underwriter Laboratories; conforms to ASME codes; factory tested before shipment.

Call your nearest CB boiler representative (see your phone directory) or send for this illustrated catalog describing the NEW CB — designed by Cleaver-Brooks, originators of self-contained boilers.



Cleaver Brooks

Cleaver-Brooks Company, Dept. C-344, E. Keefe Ave., Milwaukee 12, Wisconsin

Originators of the Self-Contained Boiler

Noel's all awhirl about

Who's Noel? Young lady who types inquiries for CHEMICAL ENGINEERING's Reader Service. Cheeriest little gal in the shop now that we've shifted to Bruning for processing your requests for manufacturer's technical data and literature.

Who's Bruning? Name of a machine that makes copying long reports and forms a breeze. Noel says she'd like to hug the guy who invented it.

Reader Service used to be quite a chore, you know. Had to type up a separate form for every item you circled on the postcard. Required copies in triplicate too. The whole business was time consuming, hard work and made it a couple of weeks before you got your information back from the manufacturer.

No more of that stuff now! Noel gets your inquiry card, makes one copy of the necessary data, sends it down for photo-copying, has all items back and on their way to the manufacturers within a couple of hours.

Neat? You bet! And judging by the way your inquiry cards are rolling in now, you readers are apparently as tickled with the system as Noel.

Guess a lot of you like all the changes we've made . . . to make it faster, more convenient for you to get in-

more engineering-minded production men read it . . . more

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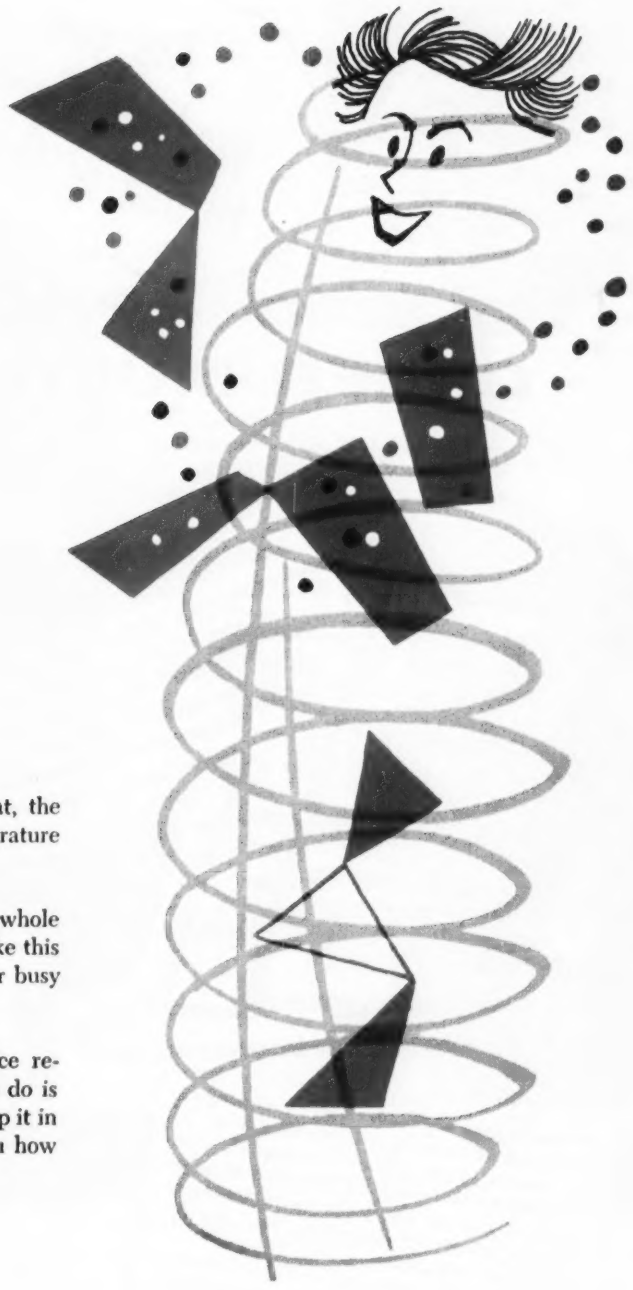

formation . . . the new Reader Service format, the simplified classifications, the New Technical Literature digests and the double free postcards.

But we're a long way from finished though. The whole department's constantly testing new ways to make this part of the book easier and more practicable for busy chemical engineers like yourself.

Meanwhile, if you haven't used Reader Service recently, why not give it a trial? All you have to do is locate the items you want, fill in the card and drop it in the mail. And Noel would just love to show you how that Bruning has updated our service.

chemical engineers profit from it . . .

Chemical Engineering

ABP ABC

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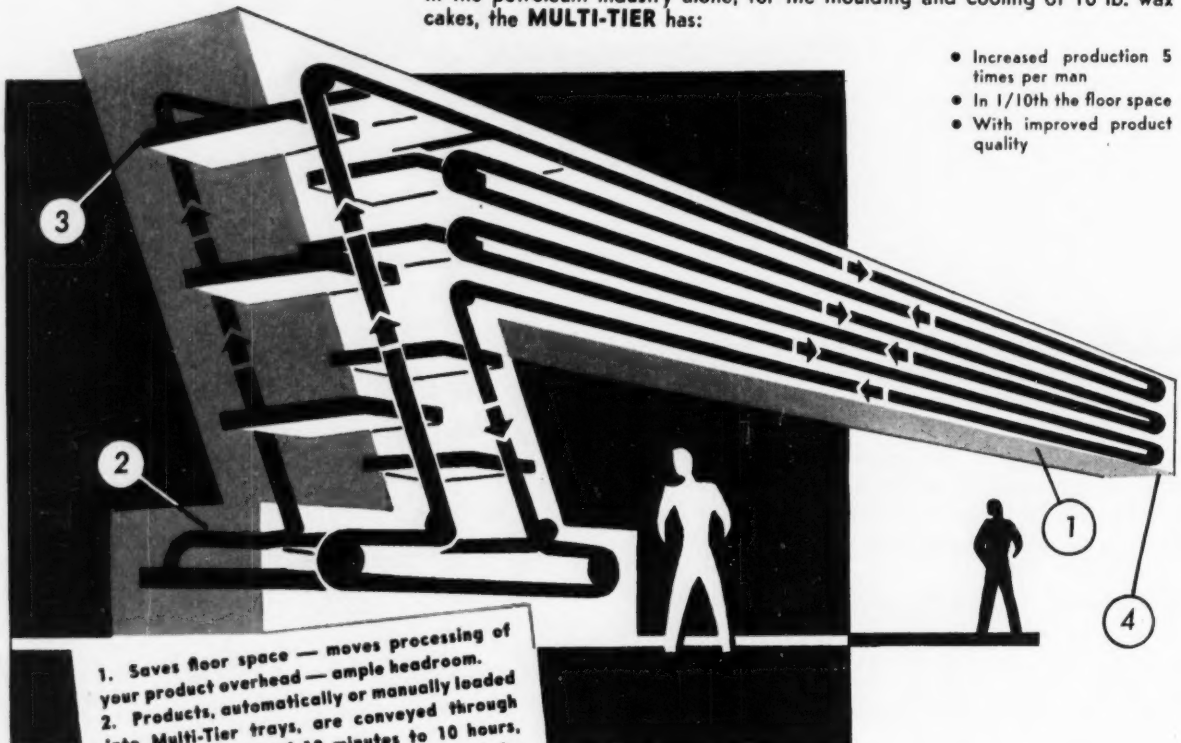

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Increased Ventilation!

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No Chemical Splashes can reach the eyes!

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We've made a good goggle even better with the newly designed all-rubber "700A." Ventilation efficiency has been stepped up more than two times by using new rubber grommets or vents equipped with chemically resistant stainless steel fine mesh screen. These vents are easily cleaned and are individually replaceable. They do not become clogged with dust in heavy exposures as quickly as the cloth vents used previously. *Air keeps coming through longer.* What's more, this increased ventilation reduces fogging of lenses to a minimum when goggle is worn in hot and humid places . . . and the fine screen grommets prevent any chemical splashes or sprays from endangering the eyes at any time.

YOUR NEAREST AO SAFETY PRODUCTS REPRESENTATIVE CAN SUPPLY YOU.

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USES — For work on acid lines, storage batteries, metal plating baths, cleaning and degreasing, foundry shakeout, railroad car cleaning, cleaning coal-handling equipment, work in ships' holds . . . in railroading over dusty runs.

FRAME — Molded from non-irritating, acid-resistant neoprene. Airtight fit helps prevent acid or dust leakage. Bridge and other face-contacting edges are very comfortable.

HEADBAND — Rubber . . . extra wide, easily adjustable.

LENS — Large impact-resistant acetate, easily replaceable. Provides exceptional wide-angle vision. IT CONFORMS TO HIGH SAFETY AND OPTICAL STANDARDS.

NOTE: Goggle may be worn over personal glasses

The SAFETY ZONE

Keep your workers in the Safety Zone with AO Safety Equipment

American Optical

SAFETY PRODUCTS DIVISION

SOUTHBRIDGE, MASSACHUSETTS • BRANCHES IN PRINCIPAL CITIES

Dewey & Almy Chemical Co. installation showing 300 GPH Gaulin Homogenizer used for making resin emulsions, shoe cements and adhesive formulations.

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Gives a faster, more uniform suspension with less temperature rise.

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Makes a smoother, better appearing product. Stops separation.

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Improves texture. Boosts shelf-life. Locks perfume in against evaporation.

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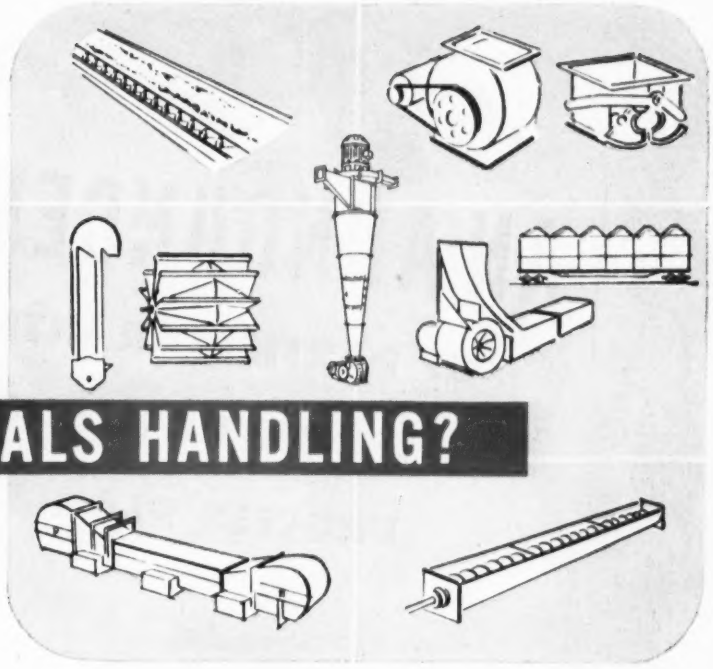
which method can save you the most in



BULK MATERIALS HANDLING?

AIR

Outstanding examples of the great savings made possible by pneumatic conveying systems are found in the Sprout-Waldron Pneu-Vac. This modern, negative-pressure system handles granular, pulverized, and flaky materials without passing them through the fan. Mechanical friction and exterior dusting are eliminated. The unit is self-cleaning. It cools, heats, aerates, or dries. There are few moving parts. As a result, Pneu-Vac pays in many ways—

99.96% material recovery... no handling losses ...increased production...greater safety...low maintenance... no product intercontamination... no fan wear...elimination of exterior dust...improved working conditions...small space requirements.

SCREW

Screw conveyors offer advantages for two types of jobs: (1) The straight-line horizontal conveying of a wide range of bulk materials over moderate distances. (2) The vertical lifting of non-fusing materials to limited heights. Sprout-Waldron vertical and horizontal screw conveyors are extremely low in maintenance and moderate in power requirements. Available in conventional helicoid, continuous sectional, and sectional types.

BELT

Belt conveyors are unequalled in speed and economy for long-distance conveying of bulk materials horizontally and up inclines. Sprout-Waldron offers sound guidance on belt conveying applications and a full line of pulleys... and is the exclusive manufacturer of the famous Belt-Saver Pulley that lengthens belt life up to 400%.

BUCKET

Bucket elevators use less power, are usually lowest in first cost and maintenance expense. However, they cannot be made as self-cleaning and contamination-proof as other materials handling systems. Sprout-Waldron offers bucket elevators in bucket sizes from 3" x 3" to 30" x 16"...wood, stainless, carbon steel, and aluminum...chain or belt, high speed or conventional.

FEEDERS

To provide the greatest possible savings in applications calling for rotary vane feeders, Sprout-Waldron offers you three advantages: (1) The most extensive line to be found anywhere. (2) Years of experience gained through pioneering in this specialized field. (3) The simplest, sturdiest and easiest-to-maintain feeders available.

Whichever type of conveying equipment fits your needs, you'll get greatest savings with a Sprout-Waldron installation. Sprout-Waldron solves your problems with a vast background of experience, complete lines of equipment and unique *"adaptioneering"* methods. Let us advise you without cost or obligation. *Please write for details.*

YOUR INVESTMENT PROTECTED
Our 88 years of service to industry is good assurance that you can obtain parts and service for the life of your Sprout-Waldron equipment.

SPROUT-WALDRON
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Equipment for SIZE REDUCTION · MIXING & BLENDING · PELLETING & CUBING · BULK MATERIALS HANDLING · PRODUCT CLASSIFICATION
Facilities for fabricating, machining, custom founding, woodworking, laboratory testing
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The Chicago Bridge & Iron Company is pleased to announce that hereafter the well known line of

CONKEY EQUIPMENT

FILTERS - EVAPORATORS - CRYSTALLIZERS

will be fabricated in CB&I's plants.

A sales and engineering office, staffed by Conkey Equipment personnel will be maintained in the New York office of the Chicago Bridge & Iron Company.

The highly specialized experience of Conkey Engineers in designing efficient units for chemical and process plants—plus the extensive fabrication and erection facilities of the Chicago Bridge & Iron Company will provide chemical and process plants with a service that cannot be duplicated.

CHICAGO BRIDGE & IRON COMPANY

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Atlanta 3	2120 Healey Bldg.	New York 6	3318—165 Broadway Bldg.
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Boston 10	1005-201 Devonshire St.	Pittsburgh 19	3205 Alcoa Bldg.
Chicago 4	2124 McCormick Bldg.	Salt Lake City 4	505 West 17th South St.
Cleveland 15	2220 Midland Bldg.	San Francisco 4	1522—200 Bush St.
Detroit 26	1503 Lafayette Bldg.	Seattle 1	1305 Henry Bldg.
Houston 2	2103 C & I Life Bldg.	Tulsa 3	1623 Hunt Bldg.
Los Angeles 17	1505 General Petroleum Bldg.		

Call the Ansul Man

for faster more effective fire protection

FAST, EFFECTIVE EQUIPMENT. A positive activating system puts Ansul's "Plus-Fifty" dry chemical to work immediately—no lag or delay. To insure full fire coverage, patented nozzles deliver the right kind of stream for your fire protection problem (low velocity or long range).

DEPENDABLE EQUIPMENT. Ansul extinguishers are water-tight, corrosion resistant, always ready for action, even after extreme weathering and exposure to wide temperature variations. Quality features like these make it possible for Ansul to back their equipment with a 5-year warranty.

TRAINING FOR YOUR PERSONNEL. At Marinette, Wisconsin, Ansul operates one of the largest and best equipped fire-training schools in America—to train your key protection men without cost or obligation. A trained Ansul man will also instruct your fire brigade at your plant.

COMPLETE PLANT SURVEY. Knowing and recognizing a fire protection problem takes a highly trained man. The Ansul man is a specialist in utilizing fire extinguishing equipment properly and effectively—he will see to it that your plant gets the best protection possible at the lowest cost.

Get in touch with your local Ansul man through the "yellow pages" or write ANSUL CHEMICAL COMPANY, Fire Equipment Div., Dept. F-111, Marinette, Wisconsin.

ANSUL

Fluidized Crystal Suspension
in
STRUTHERS WELLS
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insures

1. Economical operation—Heating and cooling surfaces stay clean
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3. Product of high purity
4. Exceptionally uniform crystals
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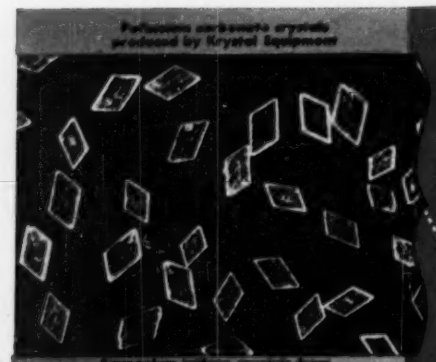
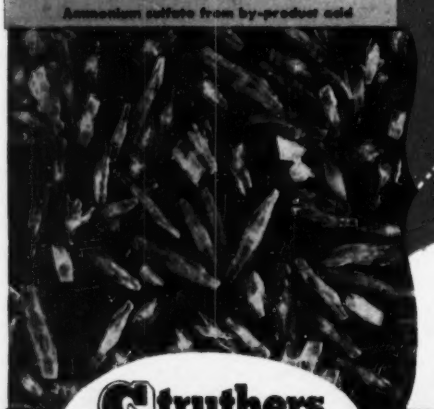


Potassium sulfate crystals produced by Krystal Equipment

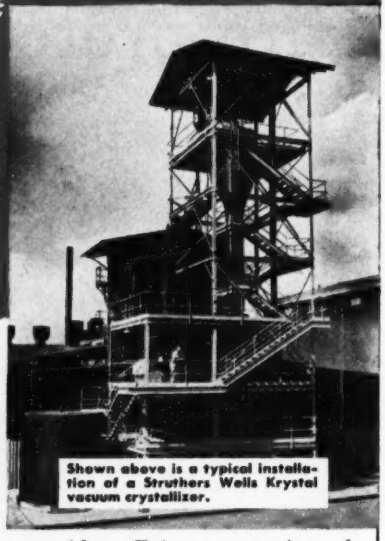
Ammonium sulfate crystals from neutralized grade acid

Potassium chloride crystals



Ammonium sulfate from by-product acid

Shop view of Krystal Crystallization Equipment. This unit is 50' 0'' high and 11'3'' in base diameter.



Shown above is a typical installation of a Struthers Wells Krystal vacuum crystallizer.

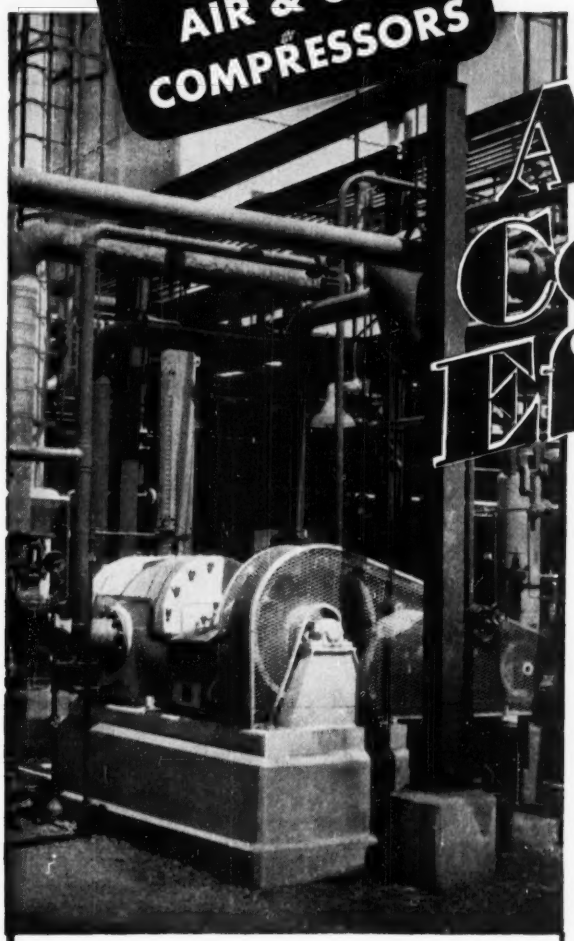
Krystal crystallization equipment provides efficient separation of crystals and mother liquor—reduces amount of wash water—eliminates dust losses—reduces caking of material in storage and produces free flowing crystals of superior appearance.

Struthers Wells

STRUTHERS WELLS CORPORATION WARREN, PA.

Plants at WARREN, PA. and TITUSVILLE, PA.
OFFICES IN PRINCIPAL CITIES

AIR & GAS COMPRESSORS



Assure Constant Efficiency

Same Pressures Maintained YEAR after YEAR Without Loss of Volume

YOU are assured of constant operating efficiency with *Ro-Flo* air and gas compressors because they are simple in construction with few parts to wear. After years of continuous operation, under normal conditions, *Ro-Flo* units have maintained constant volume output without loss of pressure, and have shown no visible signs of wear.

Today, *Ro-Flo* compressors play an important role in almost all chemical manufacturing. They are compact, self-contained units that provide continuous pulsation-free flow. And their relatively high speed rotary action eliminates vibration and shock — reduces foundation needs to a minimum.

Ro-Flo compressors are built in capacities from 40 to 3200 cfm at pressures from 5 to 40 psig. And they are only one of five separate types of air and gas handling units manufactured by Allis-Chalmers.

For detailed information on an air or gas handling unit to fit your particular need, contact your nearest A-C sales office or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4140

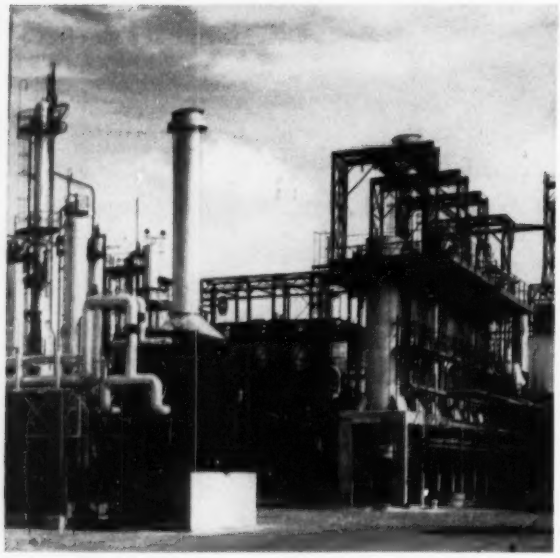
USED IN NEW ACRYLIC PROCESS

In a new acrylic process recently put on stream by the Rohm & Haas Company, Houston, Texas, a *Ro-Flo* gas compressor is handling a composite of hydrogen obtained from a low temperature distillation mixture of carbon monoxide and hydrogen. The new R & H process reduces the costs of methyl and ethyl acrylates — basic materials for synthetic organic chemicals.

Ro-Flo is an Allis-Chalmers trademark.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS



Propylene tetramer (dodecene) from propylene polymerization . .

And benezene from naphtha; basic materials for making . . .

A CHEMICAL ENGINEERING PICTURED FLOWSHEET

ALKYL ARYL SULFONATE

Synthetic Detergent

Friedel-Crafts reaction, sulfonation, are the unit processes used in this modern procedure for a synthetic detergent.

The production of synthetic detergents continues to be one of the most rapidly growing processes connected with the field of petrochemicals. In 1953, sales of synthetic detergents increased almost 24 percent over the previous year. Production is expected to reach two billion pounds within the next two years. The alkyl aryl sulfonates, an anionic-type detergent, are in greatest demand. Continental Oil Co.'s integrated operations, which are illustrated in the flowsheet, are typical of the operations involved in making a synthetic detergent from petroleum.

The basic step centers around the Friedel-Crafts reaction between benzene and propylene tetramer (dodecene)—producing a crude alkyl aryl hydrocarbon.

Purification, sulfonation, neutralization, crutching and drying complete the process.

► **Raw Materials**—Benzene is obtained by catalytically "reforming" petroleum naphtha. The propylene tetramer is produced by catalytic polymerization of propylene at a pressure and temperature of 1,000 psig. and 400 deg. F. Continental produces these raw materials at Ponca City, Okla., and Lake Charles, La., refineries and ships them by tanker to Baltimore.

► **The Process**—The Baltimore facilities are designed for the alkylation of benzene with dodecene in the presence of a Friedel-Crafts catalyst. Reaction temperatures are carefully controlled between the range of 95 to 115 deg. F. to insure good yields and alkylate quality.

The alkylation product is fractionated into benzene, light and heavy alkyl aryls and dodecylbenzene.

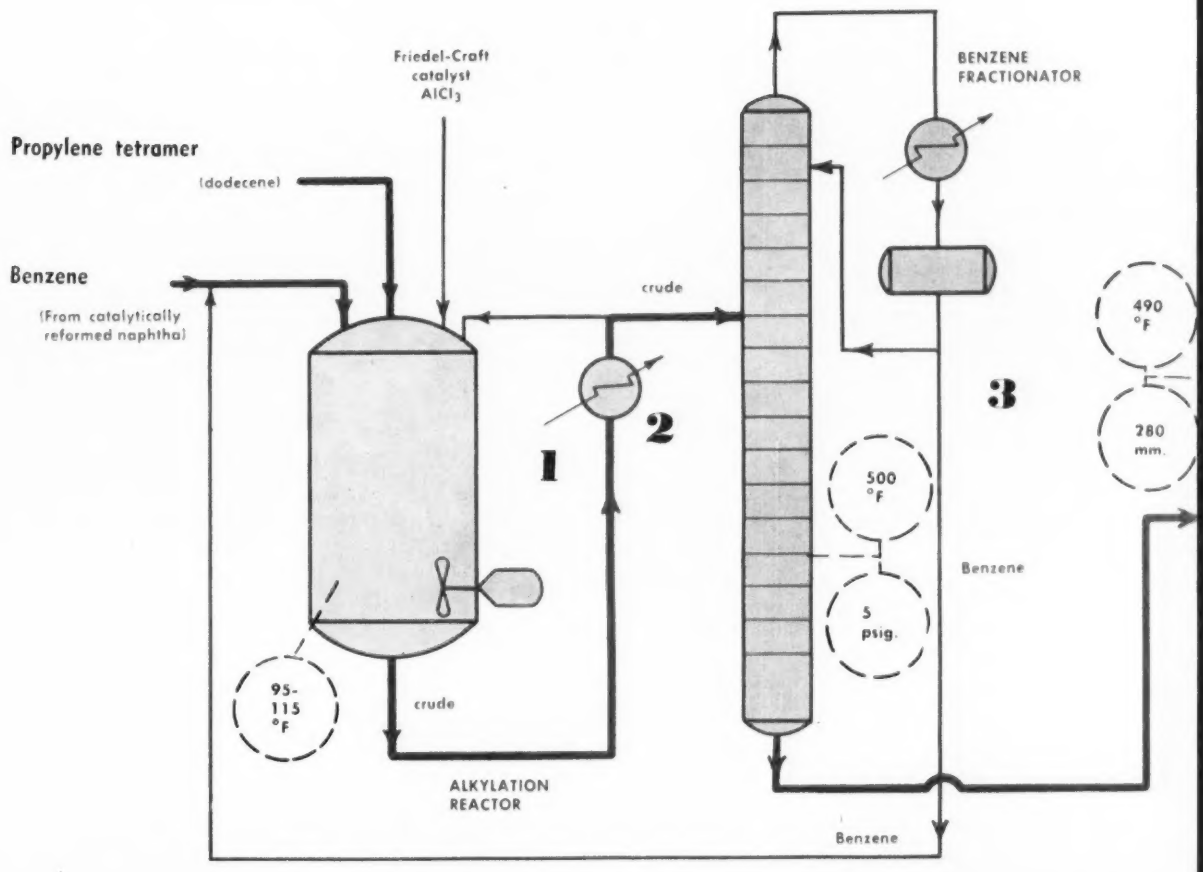
► **Sulfonation**—The sulfonation plant at Chicago is supplied with dodecylbenzene from Baltimore. This plant is equipped to sulfonate dodecylbenzene with various strengths of concentrated sulfuric acids (100.5 to 20 percent oleum). The reaction is carried out in 316 stainless steel, jacketed vessels, containing cooling coils and provisions for thorough agitation.

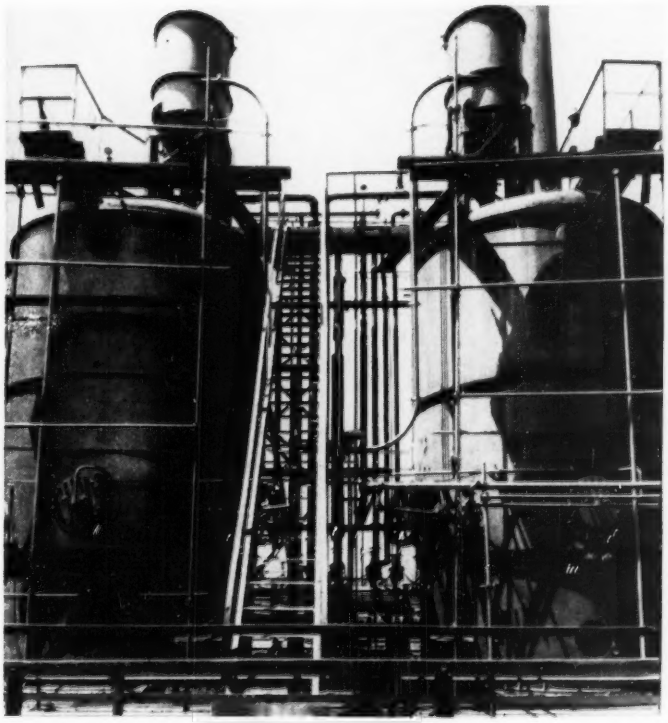
The sulfonic acid is neutralized with aqueous NaOH in a jacketed stainless steel vessel containing cooling coils. Sodium dodecylbenzene sulfonate resulting from the neutralization is a slurry of a mayonnaise consistency.

Various chemical "builders" are added to the slurry to impart desired performance characteristics in the detergent. Usual builders are—sodium chloride, phosphates, silicates, sulfate and carboxymethylcellulose.

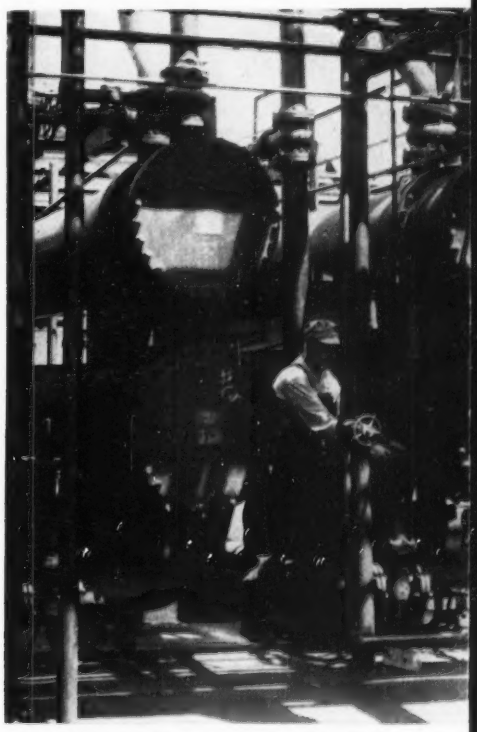
► **Crutching**—These are added to the viscous slurry in the dry state—an operation which requires effective, heavy duty agitation. The equipment employed for this step is a crutcher—a steam jacketed vessel containing a screw-type agitator to prevent the heavy builders from settling and a set of counter-rotating finger agitators.

► **Drying**—Spray drying of the synthetic detergents is typical of most spray drying operations. Dried detergent is produced in the form of "beads". These beads are air-cooled on a vibrating conveyor; classified, and packed.

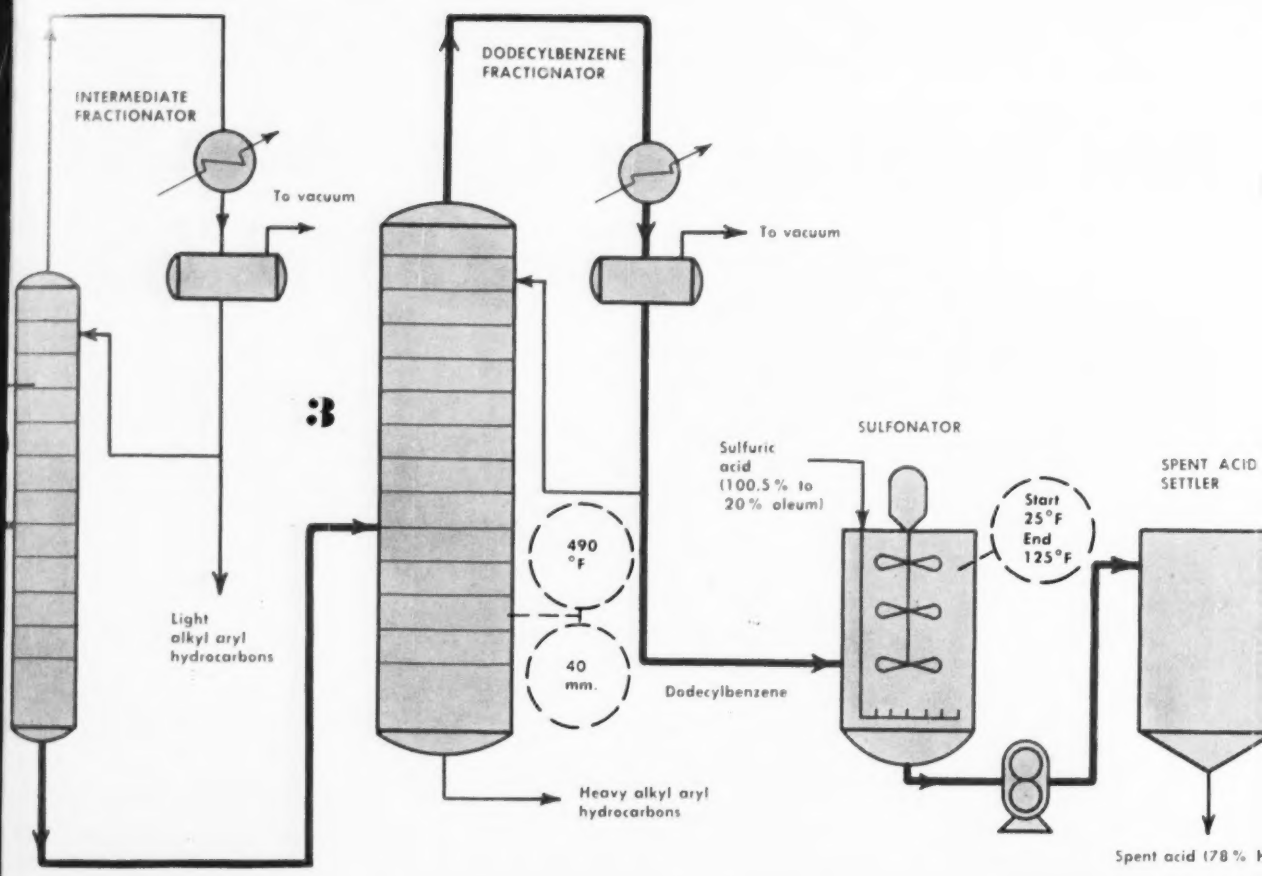




1 FRIEDEL-CRAFTS REACTORS, with pneumatic equipment for addition of catalyst. On top are cyclone separators.

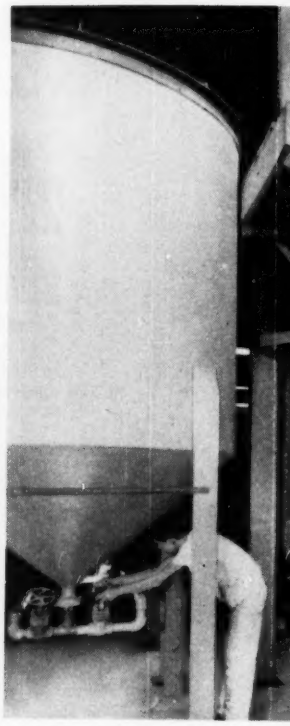


2 BANK OF HEAT EXCHANGERS for close t
ing alkylation of benzene with propylene tetra

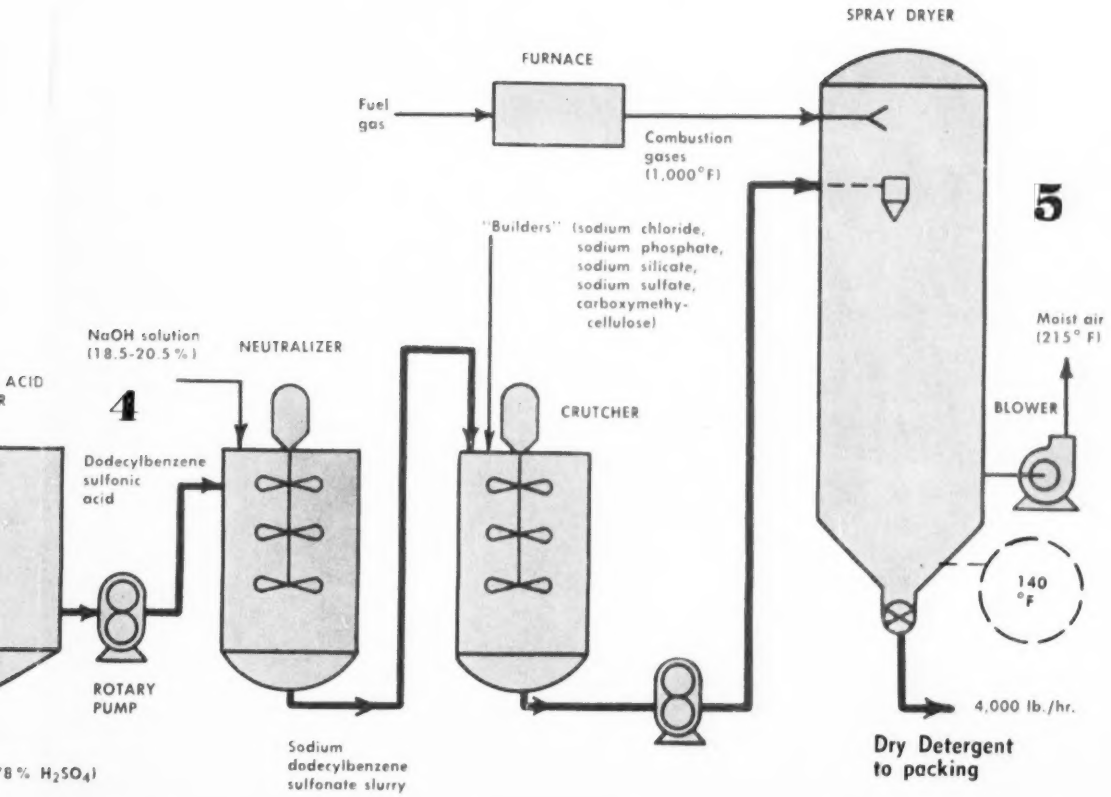


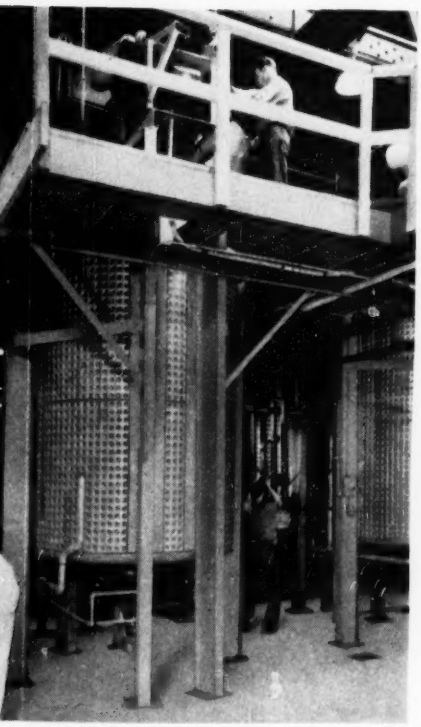
mperature control dur-
r.

3 FRACTIONATING TOWERS for the separation of benzene, heavy and light alkyl aryl hydrocarbons, from dodecylbenzene.

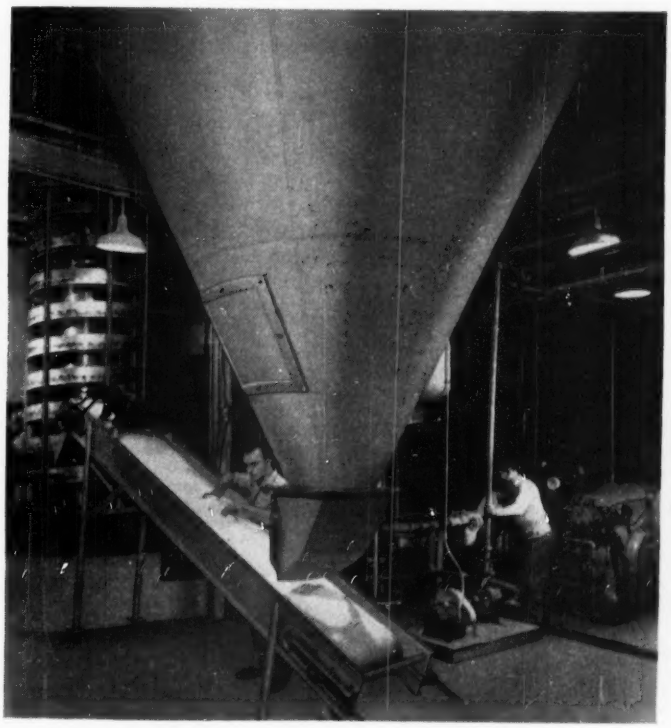


1 SETTLING TANK and
neutralizer jacket promote





nd stainless steel neutralizers. "Dimples" on ote turbulence of the cooling medium.



5 SPRAY DRYING EQUIPMENT showing the positive displacement slurry pump and spiraled conveyor used to cool dried beads.

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Men responsible for specification, operation, and maintenance of industrial piping systems will get a real "refresher" from these new Crane customer services. Both film and handbook deal with the common problems of matching up valve characteristics and specific flow control needs for the most efficient result.

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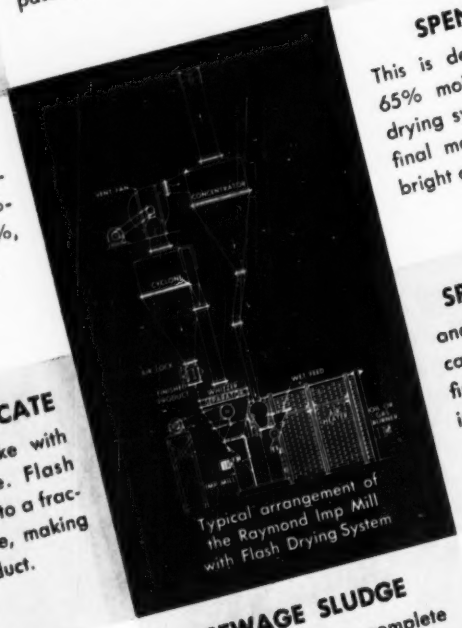

Typical arrangement of the Raymond Imp Mill with Flash Drying System

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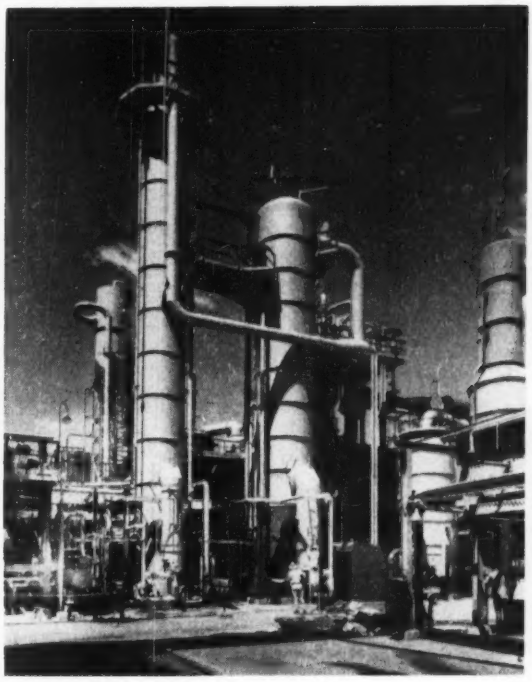

CHEMICALS AND . . .

We'll Need 94% More Electricity by 1963

Chemical and allied products makers used about 32.4 billion kwhr. of electricity last year. But ten years from now they'll probably require 63 billion.

Cheap, plentiful electric power is one of the keys to modern industrial development. It's probably not far from the truth to say that any nation with good power resources is—at least potentially—rich. The people of a power-poor nation have a tremendous handicap in their struggle to be rich in other material ways.

The United States is rich in all kinds of power resources, including hydro, coal, oil, natural gas and, potentially, nuclear. There's hardly an industry now operating in the U. S. that isn't geared to electricity, either as a consumer or as a producer of goods used by the electric utilities.

The chemical process industries are no exceptions. They consume a major share of the electrical energy sold to manufacturing industry each year. They sell quantities of goods, especially metals, to the producers of power. And they are even in the power business themselves—not just as generators of their own electric power, but as sellers of electricity as well.

► **Two Growth Fields**—Considering the close business relation between chemicals and electric power, it's not surprising that the two industries have other things in common. For instance, they are both "growth" industries, growing far faster than the economy as a whole. As a rough guide, under normally prosperous business conditions, sales of chemicals and electric power would be expected to double every 10-14 years. Sales of petroleum products might double in 15-20 years. But business activity in the economy as a whole might take 25 years to double.

It's impossible to say exactly how much electric power all the chemical process industries bought from utilities last year. The detailed figures are not available. But it was certainly more than 25 percent of the total amount of electricity sold in the United States, which was about 382 billion kilowatt hours. Three of the process industries

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ECONOMICS . . .

alone—chemicals and allied products, paper and allied products and primary metals—bought more than 75 billion kwh. in 1953.

In addition, these three industries generated an estimated 42 billion kwhr. of electricity themselves. They sold about 4.6 billion kwhr. of this to other users, and used all the rest—more than 100 billion kwhr. Among them they used more electric power than all the homes in the United States put together.

▶**Tripled Since 1939**—Take what might be called the chemical industry proper (chemicals and allied products, as the Bureau of the Census defines it). Chemical companies used an estimated 32.4 billion kwhr. of electricity in 1953. That's equal to about one-third of the amount of electricity used by residential customers last year. And it's more than three times as much electric power as the chemical industry used in 1939.

By 1963, however, chemical and allied products companies will likely require about 63 billion kwhr. of electricity. This will be an increase of 94.4 percent in only 10 years.

▶**Make and Sell**—Most people in the industry probably know that chemical companies generate a lot of their own electric power. But perhaps not so many know that the industry also sells power. Last year, it produced about 11.8 billion kwhr. of electricity and sold about 600 million kwhr. Companies may sell power to local communities, to other industry or even to electric utilities.

Most other process industries use a lot of electric power. Companies that make paper and allied products, for instance, use about one-third less than chemical companies, although they generate even more themselves. But the champion users in all industry are the primary metals industries—also part of the process industries. They consumed an estimated 61.4 billion kwhr. last year.

The steel industry used the most, about 31 billion kwhr. Aluminum, however, is threatening to overtake steel as the big user of electricity. Estimates vary, but the

aluminum companies probably used about 22.5 billion kwhr. of electric power to produce primary metal in 1953. As recently as 1950, they used only about 13 billion kwhr. The chances are that within 15-20 years aluminum companies will be using as much power as all the primary metals industries put together do today.

Here's a table that puts these figures in prospective. Figures prior to 1953 are from Electrical World, a McGraw-Hill publication. Last year's figures are estimates.

Electric Energy in Manufacturing

(Billion kwhr.)

Year	Bought	Generated	Sold	Used
1929.....	36.2	20.9	2.0	55.1
1939.....	44.8	28.6	2.9	70.5
1947.....	102.8	43.9	5.8	140.9
1952.....	152.1	56.1	7.3	201.0
1953.....	172.4	61.4	7.4	226.4

▶**More Will be Needed**—Probably nothing is surer than that U. S. industry, including the chemical industry, will continue to use more and more electric power in the future. A glance at the growth trend for power sales—nine or ten percent a year—is probably evidence enough. But there is plenty of other evidence.

One obvious point is that some of the industrial products that are growing fastest can only be made economically with electric power, as far as we know today. That's true for aluminum, for instance, and for the other light metals—titanium and magnesium. Industry constantly tries to reduce the amount of power it has to use, just as it tries to cut other costs. For instance, it generally takes about 9 kwhr. of electricity to produce a pound of primary aluminum, but some producers may have this down around 7-8 kwhr. per lb. But sales of their product are growing a lot faster than they can cut their unit use of electric power.

▶**More Machinery** – There are other reasons for expecting use of electric energy to go right on growing fast. One is that industry is increasingly mechanized. Machines are added to increase production, improve quality or cut labor costs. But, whatever the motive, the machines generally use electric power.

The outlook for industrial costs

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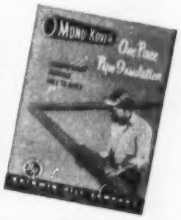

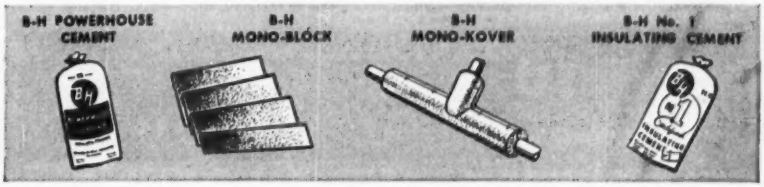

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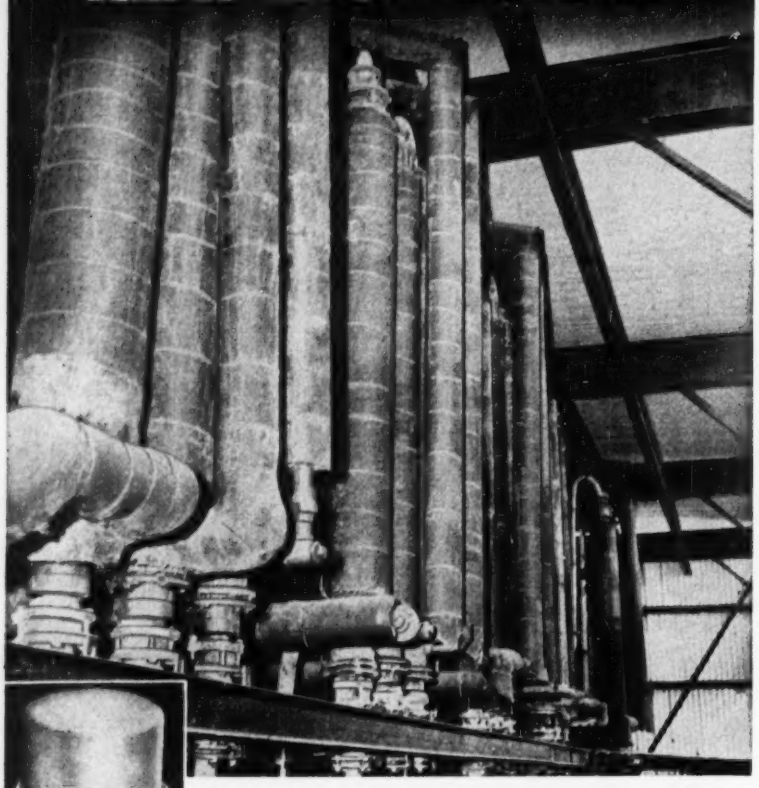

Photo shows 7-tube, single pass, 9-foot long IMPERVITE heat exchangers installed in the production facilities of a large manufacturer of agricultural, industrial and pharmaceutical chemicals. Over 50 IMPERVITE heat exchangers are currently in use at this plant as reflux condensers on acid vapors from organic reactions.

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High efficiency IMPERVITE heat exchangers from 7 to 241 tubes feature highest quality workmanship and design. Available for single and multi-pass applications, IMPERVITE exchangers are used as preheaters, boilers, condensers, coolers and absorbers in a wide range of processing work with acetic acid, ammonium sulphate, caustic soda, hydrochloric acid, sulphuric acid, chlorination etc.

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ECONOMICS . . .

also favors greater use of electricity. This is an era of rising costs—inflation. And economists are pretty well agreed that costs will continue to rise in the future. There may be short periods when they go down, but over the long pull they are expected to rise. And this prospect gives electric power a competitive advantage, because its cost is not likely to rise as fast as many other costs.

The price of industrial electric energy is likely to be relatively stable over the long run, even though the electric utilities will have to pay more for the machines, fuel and labor they use to produce it. One reason is that the equip-

— EAVESDROPPING —

". . . atomic energy plants constitute no real threat to existing hydro-electric developments."

J. A. Fuller*

"Nobody doubts that [atomic power] can be produced; in fact, it is being done now on an experimental basis. Nobody knows what the capital or operating costs, on a commercial basis, will be and it would appear that complete answers to these questions are some five years away. It must be remembered that, when we talk of atomic energy, we are referring only to atomic fuel for raising steam in substitution for conventional fuels, such as coal, oil or natural gas. Broadly speaking, this substitution, from the point of view of capital cost, involves only about 30 percent of the total investment required to deliver power to the customer. Turbines, generators, transmission and distribution lines and auxiliary equipment, comprising 70 percent of the capital investment, will still be required. The economic feasibility of atomic enegry will therefore rest on comparative costs with thermal plants. To the best of present knowledge of the subject, atomic energy plants, if at all economic, constitute no real threat to existing hydroelectric developments.

* President, Shawinigan Water and Power Co., Montreal, Quebec.

ment used to produce electric power is steadily becoming more efficient.

On the average, utilities can produce a kwhr. of electricity with about 1.07 pounds of coal today, compared to about 1.3 pounds of coal just six years ago. The newest plants are even more efficient. Furthermore, modern generating equipment can be kept in operation longer than older equipment before it needs to be repaired, which means big gains in capital costs.

But, above all, the business of generating electric power is one that gains in efficiency as its volume increases; the bigger a generating plant, or an individual generator, the more efficient it is. As sales of power rise, the utilities build bigger and bigger plants. The resulting gains in efficiency will continue to be made as electric power sales rise in the future.

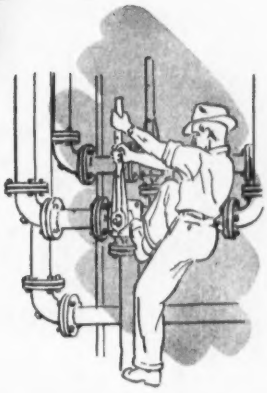
► **Lots of Reserve**—But perhaps the best reason for expecting industry to use more electric power is the one mentioned at the beginning of this article: The U. S. is rich in power resources. We still have quite a lot of undeveloped hydroelectric potential in our rivers, and an abundance of natural fuels. In coal, especially, the United States is fabulously rich. These fuels will become more expensive as time passes, and the highest quality resources are used up. But new fuels, like uranium, and rising efficiency will help keep costs down. With such wealth available, it's bound to be used.

Booming Use Seen for Polyvinyl Acetate Paint

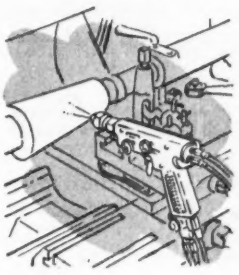
There's going to be a tenfold increase in the use of polyvinyl acetate paints within the next four years. According to H. J. Zahrndt of National Starch Products, Inc., about 3-4 million gal. a year are being used now. But this will rise to 40 million gal. in the next four years and by 1960 usage should be at least 60 million gal. annually.

Although PVA paints cost more than latex paints, their longer life is felt to offset this disadvantage.

VALVES WON'T STICK



With Colmonoy Hard-Facing



Valves stick because the metal to metal contact between plug and body causes galling. Galling occurs because the metal used in corrosion resistant valves is relatively soft. These troublesome valves can be made to work easily by hard-facing the plugs and seats with a COLMONOY alloy. COLMONOY is inherently hard, and has a *low coefficient of friction*, which gives it *high galling resistance*. It also has *excellent corrosion resistance*, making it the perfect material for these applications.

COLMONOY alloys may be applied to the plugs in two ways. Oxy-acetylene rod application can be done by any welder. With a COLMONOY Spraywelder, powdered COLMONOY is sprayed on and then fused, forming a smooth overlay. Sprayed overlays require but a fraction of the usual finishing time. Both methods are quick and easy, give long, smooth-turning valve service.

When you order new valves—

Valves used under corrosive conditions have been made mostly from integral castings of some good corrosion resistant alloy. Now COLMONOY alloys, much harder and more resistant to corrosion, are being welded to the fluid contact surfaces of valves made from strong but inexpensive carbon steel. The result is a stronger, freer working valve with higher, all-around corrosion resistance, and the ability to stand 1000° F. service. Specify COLMONOY hard-faced steel valves for the best and longest anti-corrosion service possible.

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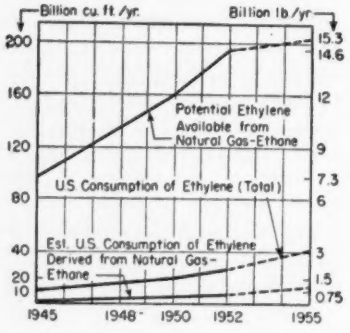
ECONOMICS . . .

Currently the biggest uses are on masonry, stucco interiors and as a primer-sealer. Greatest growth, however, is expected to be in exterior coatings, says Zahrndt.



Chemicals from Natural Gas Still An Infant

The chemical industry has scarcely tapped the potential sources of hydrocarbon raw materials and there should not be a bottle neck in continued chemical expansion in the foreseeable future. But possession of ethane-containing gas streams does not in itself represent an "open seasame" to the golden opportunity of going into the chemical business.

These conclusions were drawn by R. L. Bateman and T. R. Ragland, both of Carbide & Carbon Chemicals Co., in a talk on chemicals from gas, petroleum and coal given to the American Gas Association recently. And the statements were backed up with facts.

During the early stages of development of the synthetic chemical industry, the primary sources of olefin gases were propane and butane fractions extracted from natural gas. In the late 1930's refinery gas streams from crude oil cracking operations became an important added source of olefins.

Since ethane is the chief constituent other than methane in natural gas, our industry after World War II turned to this source for a major portion of its raw material needs. Ethane averages about 4 percent of the entire volume of gas produced in the U. S.

However, because of its high vapor pressure, ethane is harder to

remove, requires more extensive and expensive installations than in the case of units for propane and butane. Also, it cannot be transported and stored in bulk in conventional facilities.

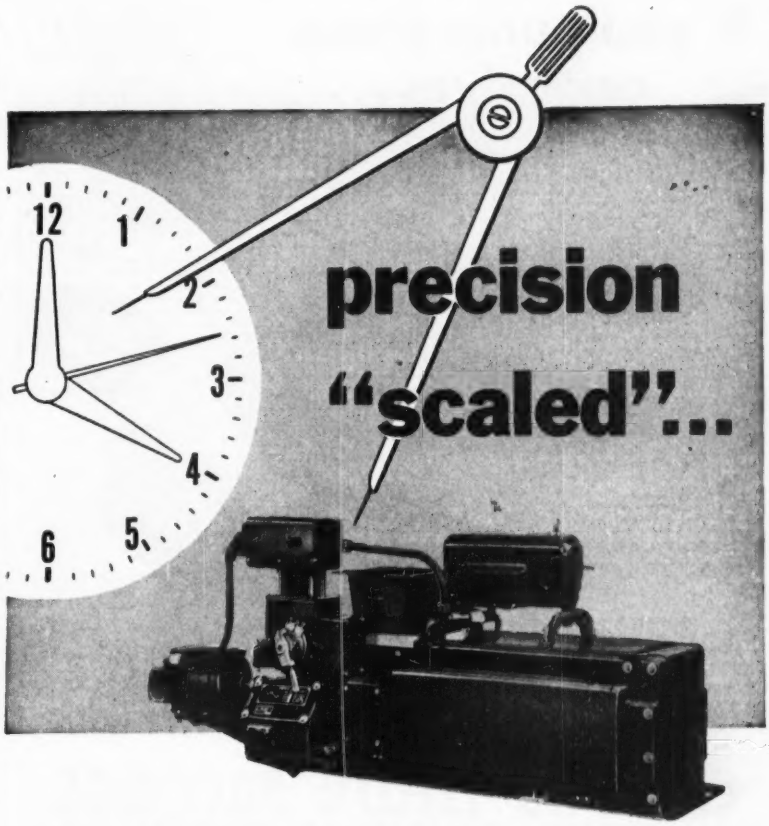
These difficulties determine some of the conditions under which ethane can be economically used to make chemicals. For instance, assume a natural gas stream contains five percent of recoverable ethane but is only at 100 psi. To effect a separation from methane, the pressure of the entire stream must be raised to several hundred psi. and placed under high-grade refrigeration and rectification.

It follows, therefore, that 20 volumes of natural gas must be compressed and processed to recover one volume of ethane. Under these conditions the investment in compressor, refrigeration and distillation equipment may be prohibitive.

U. S. natural gas production in 1952 was about 8.6 trillion cu. ft., according to the Bureau of Mines. Assuming an average ethane content of four percent with three-quarters of this in suitable locations or of sufficiently high content to warrant separation, the recoverable ethane totals 0.26 trillion cu. ft. The expected ethylene from ethane yield is 75 percent. Potential ethylene available from natural gas ethane in 1952 was therefore 0.2 trillion cu. ft.

But during the years that natural gas has been used to make chemicals, the availability of olefinic hydrocarbons as a coproduct of refinery cracking units has broadened the base of raw materials. It's estimated that only approximately 55 percent of the olefins for synthetic chemical manufacture are made from natural gas, 45 percent coming from refinery gases or petroleum fractions.

The chart on the opposite page shows today's ethylene picture. The total ethylene potentially available from natural gas ethane was 200 billion cu. ft. in 1952. Total U. S. consumption of ethylene for chemical manufacture from all sources totaled only 27.4 billion cu. ft. that year, according to the U. S. Tariff Commission. Of this, 15.1 billion



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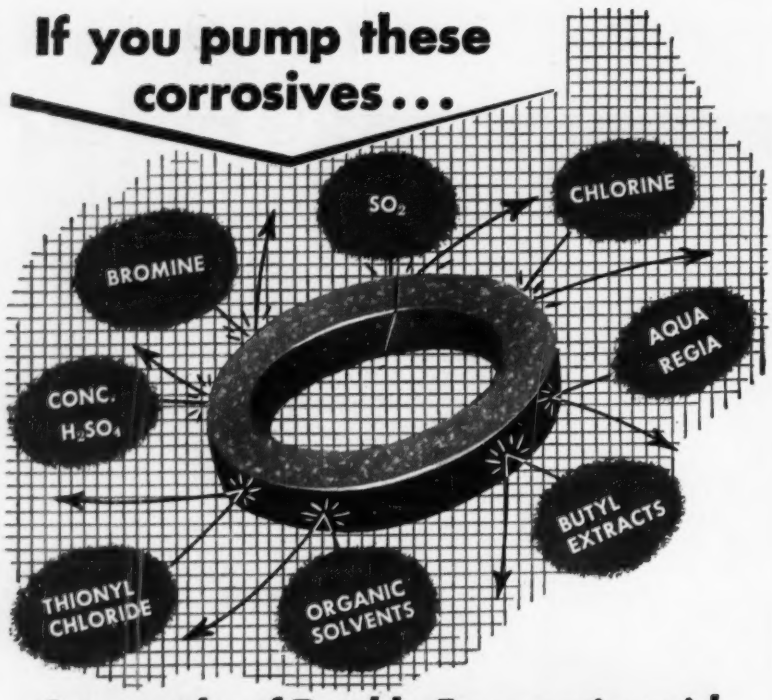

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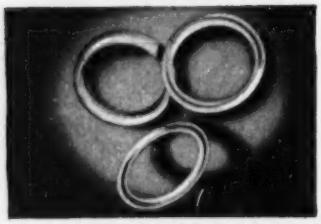


TEFLON V-TYPE PACKINGS

For reciprocating pumps and hand, air and motor operated valves handling corrosive materials. Lips of very sensitive pressure rings expand proportionately to increased operating pressure thereby preventing leakage. Suitable for temperatures from -150° F. to 550° F. Unsuitable for centrifugal or rotary pumps. Supplied in bulk or in complete sets to fit specific stuffing boxes.

Chemical & Power Products engineers are packing and gasket specialists with complete fabricating facilities to meet your specific requirements. Write for our complete Teflon Packing and Gasket Catalog.

*du Pont Trademark

CHEMICAL & POWER PRODUCTS, INC.

The Original Fabricators of Teflon Packings and Gaskets

5 Broadway, New York 4, N. Y.

ECONOMICS . . .

cu. ft.—55 percent—came from natural gas.

But propane and butane are also cracked to ethylene so a reasonable assumption is that not more than 7.6 billion cu. ft. of ethylene was obtained by ethane cracking. This is only 3.8 percent of the potential ethylene recoverable from natural gas that could be used for chemical manufacture today.

EAVESDROPPING

". . . interdependence illustrates the need for supporting an international forum like the U. N."

J. D. Zellerbach*

". . . Now I will try to show why it is important that we support the United Nations, if only from the standpoint of our own self-interest.

"A specialized activity of the U. N. which is doing a particularly effective job at relatively little cost is the Technical Assistance Program: hundreds of technicians from abroad absorbing our methods, philosophy and friendship; hundreds of our technicians in the field demonstrating American know-how.

"Many of the raw materials which are of the utmost importance to us today come from the undeveloped areas of South America, Asia and Africa. Without them our costs would rise, our standard of living would fall and some production would possibly not go on at all. Yet we have a penchant for talking —and sometimes acting—as if we were a self-sufficient nation.

"A nation whose international dependence has caused it to stockpile some $7 billion of scarce materials can ill afford to blind itself to business and international realities.

"Others, of course, look to us for wheat and cotton and autos and machinery. This mutual interdependence between ourselves and other countries of the free world illustrates the need for supporting an international forum like the U. N.—support which from every hard business point of view is to our advantage."

* President, Crown Zellerbach Corp., at a San Francisco luncheon in his honor.

New Basis for Oil Spending Reports

Beginning immediately, McGraw-Hill's Economics Dept. will start reporting capital spending in the petroleum industry on a more complete basis.

Previous petroleum statistics have been on the same basis as those published by the Dept. of Commerce. These have the disadvantage of splitting petroleum up, listing part under manufacturing, part under mining and parts under trade and transportation. In the last three categories, petroleum figures are not separated from the totals. Also, only companies primarily in refining were included.

Now, however, the entire oil industry will be covered. The table below gives actual and planned spending to supplement the seventh annual McGraw-Hill survey figures reported in *Chemical Engineering* last month (p. 339).

Oil Industry Capital Spending

(Millons of Dollars)

	Actual 1953	Planned 1954	% Change 1953–1954
Production	2,197	2,282	3.9
Refining	1,056	1,277	21.0
Transportation	465	319	−31.3
Marketing	507	548	8.0
Other	—	137	—
Total	4,225	4,563	8.0

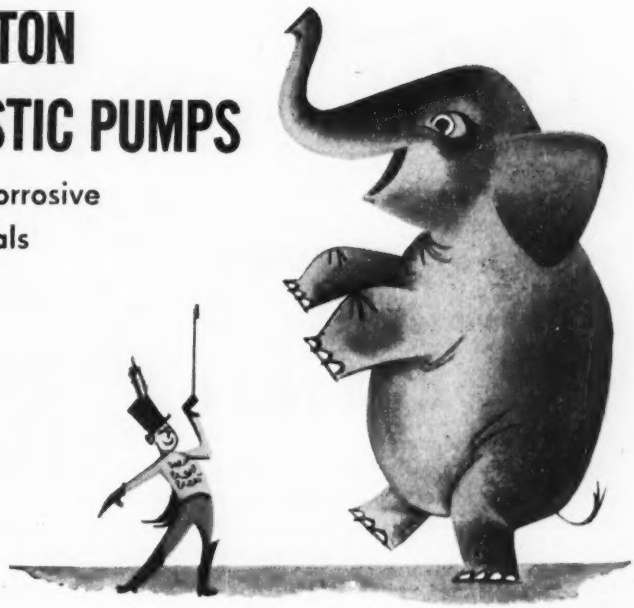
Try These Hints on Your Next Revamping

Chemical and petroleum companies, probably without parallel in other industries, often have their plants outmoded long before the equipment's useful life is realized. Confronted with acres of buildings, vessels, pumps, piping and other facilities, chemical management is all too frequently faced with the question: Should we revamp?

John M. Black of the M. W. Kellogg Co. has some good ideas about how to answer this. At a recent American Chemical Society meeting, Black said, "I am not aware of any conversion job which did not finally prove to be a successful financial effort. However, the tendency is to underestimate the original cost of the reinvestment."

VANTON PLASTIC PUMPS

tame corrosive chemicals



Flex-i-liner **PUMPS are becoming industry's standard for those difficult to handle corrosive solutions and abrasive slurries, such as HCL, HF, NaOH, H_2SO_4, distilled H_2O, $FeCl_3$, HCOOH, and $Al_2(SO4)_3$, because their unique design eliminates stuffing boxes, shaft seals, gaskets and check valves.**

NO METAL IN CONTACT—The only parts in contact with the fluid being pumped are the outer surface of the durable precision molded flexible liner and the inner surface of the pump body block, both of which are available in a wide selection of corrosion and contamination resistant materials.

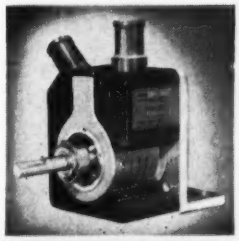
FLEX-I-LINERS:

● Pure gum rubber ● Natural Rubber ● Neoprene
● Hycar ● Buna N ● Silicone ● Vinyl ● Compar

BODY BLOCKS:

● Polyethylene ● Bakelite ● Buna N
● Lucite ● Unplasticized PVC
● Available in stainless steel for special applications.

Flex-i-liner Plastic Pump



NO STUFFING BOX—Elimination of stuffing boxes, packing glands and shaft seals, avoids the possibility of external leakage and prevents contamination of the transferred liquid by oil or grease.

SELF PRIMING—Vanton self priming plastic pumps give immediate operation in any position.

GET THE FACTS—Write for bulletin "VP" and the full story of Vanton plastic pumps.

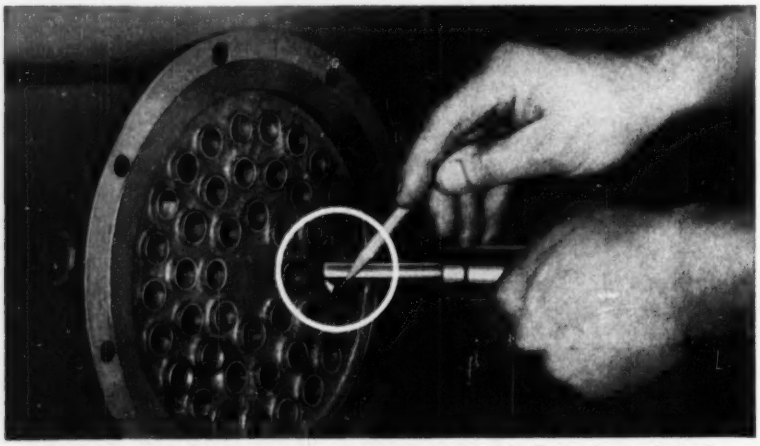
OUR CORROSION RESISTANT PRODUCTS FOR FLUID HANDLING include a complete line of Buna N and Natural Hard Rubber centrifugal pumps, valves, pipe and fittings. Bulletin BHR on request.

VANTON
PUMP & EQUIPMENT CORP.
EMPIRE STATE BUILDING • NEW YORK 1, N. Y.

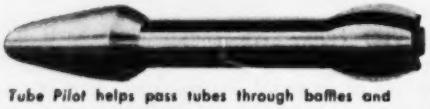
See what WILSON's done with the

TUBE CUTTER!

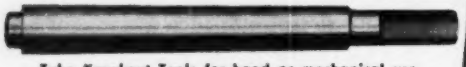
This new Wilson Tube Cutter is making a big hit. Simple in design . . . very short . . . can be chucked into any electric or air drill . . . and the cutter bits are easily replaceable. Performance? Well, in a test on ¾"-16 gage tubes, the average time was less than 3 seconds apiece, and the cuts were practically burrless. It's a fine tool . . . and reasonably priced, too.



New Wilson Tube Cutter is easy to use and does a fast job. Cutter sizes and shanks available to meet all heat exchanger requirements.



Tube Pilot helps pass tubes through baffles and far sheet when retubing.



Tube Knockout Tools for hand or mechanical use.

DON'T FORGET!

For faster, lower cost tube cleaning
WILSON TUBE CLEANERS

For easier, better rolling of tubes
WILSON TUBE EXPANDERS

Representatives in all principal cities

THOMAS C. WILSON, INC.

21-11 44th Ave., Long Island City 1, N. Y.

Cable Address: "Tubeclean" New York

WILSON

TWB88A

TUBE CLEANERS • TUBE EXPANDERS

ECONOMICS . . .

In new plant construction—with fixed price bids—the figures are apt to be quite accurate and can only be affected by such troubles as inflation and strikes. In revamp projects, though, estimates can be grossly wrong unless all the problems peculiar to this type of work are carefully considered.

Probably the first important step is to check the existing plant against the original design, says Black. Changes are often made during repair work that would incur costly delays in a reconstruction project. The extent of corrosion damaged must also be determined and the performance characteristics of equipment known.

While revamping saves the cost of new land, construction problems are increased because of lack of working room. Too little near-by area for construction offices, shops, etc., can easily double costs.

Cost data is normally available covering a new comparative plant of the process under consideration. A general approach for assembling a figure covering a revamp alternate includes the following steps:

- Preliminary process study.
- Roundup of data on existing plant conditions.
- Detailed process study.
- Survey of existing equipment.
- Study of land and construction costs.
- Cost of shutdown time.
- Labor considerations.
- Obsolescence of machinery and instruments on hand.
- Detailed engineering.
- Estimate survey.

Mathieson Absorbs USI Antifreeze Business

U. S. Industrial Chemicals Co., a division of National Distillers Products Corp., has transferred its antifreeze sales personnel and private labels to Mathieson Chemical Corp., Baltimore, Md. The latter is a producer of ethylene glycol and methanol and until now was a basic supplier of these to USI.

Two labels are involved: "USI Permanent", glycol type, and "Su-

per Pyro", methanol type. Mathieson will use the three USI packaging plants at New Orleans, Chicago and Baltimore. It also will continue to use its own packaging plants at Chicago and Rochester, N. Y.

Fischer & Porter Sees $100 Million Sales

Although its total sales in the fiscal year that ended April 30 were only slightly over $8 million, Fischer & Porter Co. of Hatboro, Pa., is blithely forecasting $100 million annual sales volume for itself within the next ten years.

According to Kermit Fischer, president of the instrument company, 50 percent of the anticipated increase will come from sales of a new F & P measuring instrument called the Digi-Coder. The rest will be a natural outgrowth of the rapidly rising industrial trend toward fully integrated automatic production operations.

The Digi-Coder upon which so much hope is placed is a device that is said to read hundreds of temperature, pressure, flow and other meters at one time and translate them into a typewritten report. This eliminates the need for an engineer to read them directly.

	Cost of Living	Hourly Earnings
January	115.1	$1.80
February	115.0	1.79
March	114.8	1.79
April (Est.) ...	114.6	1.79

Optimistic Outlook For Chemical Workers

Although the cost of living index has been riding down slowly since January, average hourly earnings in the chemical and allied industries have leveled off. And a rash of labor contracts is coming up for negotiations soon in industries closely related to chemicals. They may well keep earnings high despite a sliding cost of living.

Teflon*... Your Best Source Is JOHN CRANE

SHEET

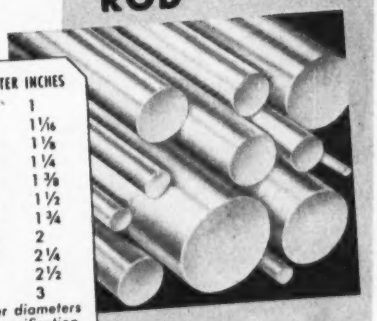
Thickness Inches	Nominal Size
1/16	12 x 12
3/32	18 x 18
1/8	24 x 24
3/16	36 x 36*
1/4	48 x 48*
3/8	
1/2 & Up	

* Can be furnished in 1/2 sheets

ROD

DIAMETER INCHES	
1/4	1
5/16	1 1/16
3/8	1 1/8
7/16	1 1/4
1/2	1 3/8
9/16	1 1/2
5/8	1 3/4
3/4	2
7/8	2 1/4
	2 1/2
	3

Other diameters on specification



TUBING

TYPICAL SIZES INCHES	
O. D.	I. D.
3/8	1/4
1/2	3/8
3/4	1/2
1	3/4
1 1/2	1
2 1/2	1 1/2
3	1 3/4

HERE'S WHY: You can order in quantity and in a wide variety of sizes—and be certain of complete uniformity throughout. Our strict density control assures you thoroughly non-porous Teflon—free from any flaws which might possibly affect your end use or product. Dimensions are accurate to your most critical tolerances—no rejects, waste of material or loss of time. You get product purity—Teflon at its best in every one of its remarkable characteristics. Delivery is prompt—you get the quantity you want when you want it.

Since the availability of Teflon, "John Crane" engineers have worked with Industry to successfully solve innumerable problems and develop new applications. *You can benefit from their experience and know-how.*

Characteristics of Teflon

CHEMICAL
Completely inert.

ELECTRICAL
Very high dielectric strength. Extremely low power factor.

THERMAL
Temperature range −300° to +500° F.

MECHANICAL
Strong, flexible, weather resistant.

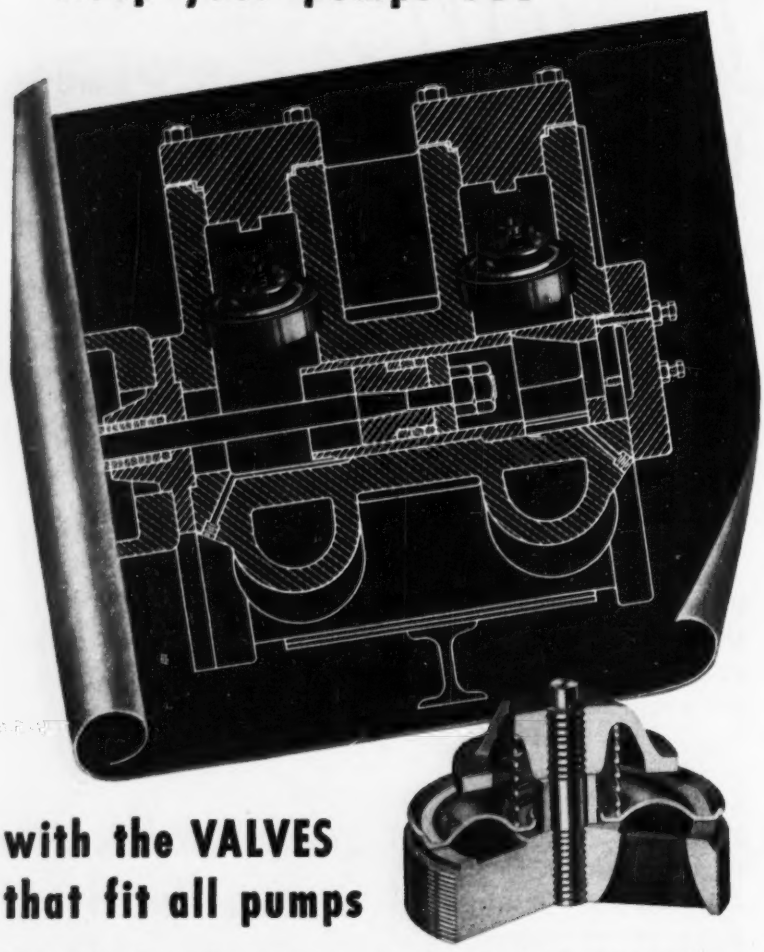
LOW COEFFICIENT OF FRICTION
Absolutely non-stick.

* DuPont Trademark

Request full information and ask for our bulletin, "The Best in Teflon." Crane Packing Co., 1809 Belle Plaine Ave., Chicago 13, Ill. • In Canada: Crane Packing Co., Ltd., 617 Parkdale Avenue, N., Hamilton, Ont.

JOHN CRANE CRANE PACKING COMPANY

Keep your pumps FIT



with the VALVES that fit all pumps

Your old reciprocating pumps can be rehabilitated or adapted to new and severe service by fitting them with DURABLA Pump Valve Units.

The patented corrosion-resistant, non-warping, pressed metal valve, making only "point contact" on the stud or sleeve, cannot bind or hang up on the guard stem. The open-type guard assures free flow of liquid and eliminates any possibility of spring clogging from hardening liquids.

DURABLA Pump Valves will operate freely under extremes of high or low temperature, with highly corrosive fluids, and in any position. They will handle vacuums of one micron or discharge pressures of thousands of pounds per square inch.

Standard equipment on many pumps, DURABLA Valve Units are made in fifteen sizes, designed to meet over 300 variations in installation requirements. They will fit any reciprocating pump, new or old.

A DURABLA engineer will be glad to help you work out a plant survey covering your valve requirements. Write for bulletin or engineering assistance.

DM-2

DURABLA

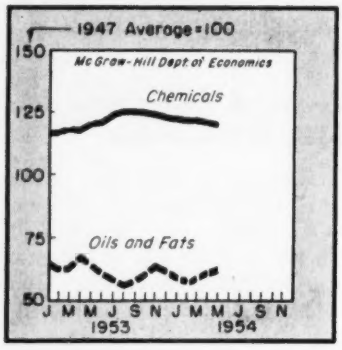
DURABLA MANUFACTURING COMPANY

114 LIBERTY STREET • NEW YORK 6, N. Y.

THIS MONTH'S

Industry

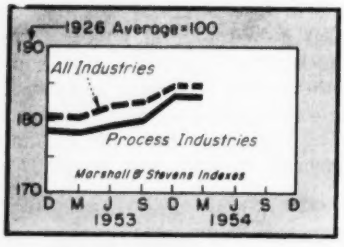
PRICES...



CHEMICAL PRICES.....122.1
OILS & FATS PRICES.....63.4

As of May 1, 1954	122.07	61.08
Last month	122.74	61.08
1 year ago.....	120.42	64.86
2 years ago.....	120.21	52.00

EQUIPMENT COSTS...



ALL INDUSTRY AVERAGE.....184.8
PROCESS INDUSTRY AVERAGE..183.5

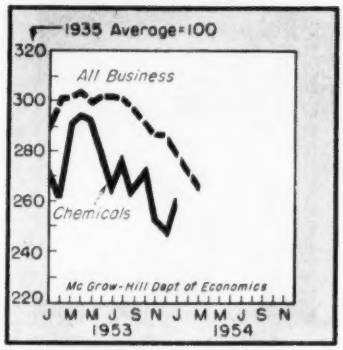
	Dec. 1953	Mar. 1954
Process Industries		
Cement mfg.	177.8	177.8
Chemical	186.4	186.4
Clay products	172.6	172.6
Glass mfg.	176.2	176.2
Paint mfg.	179.5	179.5
Paper mfg.	179.8	179.8
Petroleum ind.	183.0	183.0
Rubber ind.	185.4	185.4
Related Industries		
Elec. power equip...	188.3	188.3
Mining, milling ...	187.4	187.4
Refrigerating	204.9	205.1
Steam power	175.7	175.7

Compiled quarterly by Marshall and Stevens, evaluation engineers, Chicago and Los Angeles. See *Chem-Eng.*, Nov. 1947, pp. 124-6 for method of obtaining index numbers; March 1954, pp. 214-5 for annual averages since 1913.

Trends

Douglas Greenwald

CONSUMPTION...

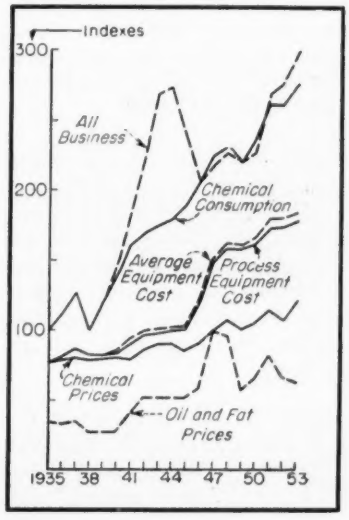


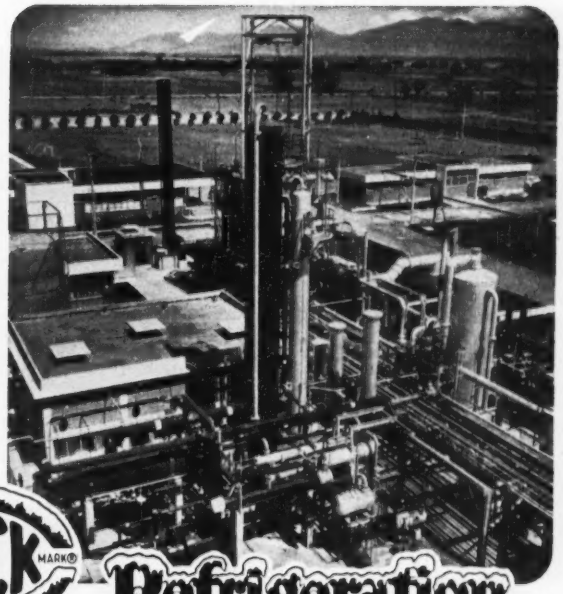
BUSINESS ACTIVITY (March)..266.3

CHEMICAL CONSUMPTION

	Feb. (Prelim.)	Jan. (Rev.)
INDEX	**252.7**	**262.4**
Fertilizer	62.40	61.28
Pulp & paper	28.62	30.91
Petroleum ref.	25.74	28.01
Iron & steel	12.99	14.58
Rayon	21.86	23.99
Glass	21.95	22.65
Paint & varnish	24.03	25.19
Textiles	9.18	9.80
Coal products	9.98	11.21
Leather	3.90	3.90
Explosives	8.07	7.67
Rubber	5.41	5.48
Plastics	18.53	17.73

LONG TERM...





TRADE FRICK MARK® Refrigeration

Used in Largest Fertilizer Plant in Latin America

Guanos y Fertilizantes de Mexico S.A., the largest fertilizer plant in Latin America, produces 200 metric tons of ammonia sulphate daily, as well as large quantities of liquid ammonia and 200 metric tons of super phosphate.

Frick refrigeration is used to cool a circulating solution of cuprous ammonium formate, a purifying agent in the synthesis process; and to cool high pressure synthesis ammonia gas to condensing temperature to produce liquid ammonia. In addition, a Frick booster compressor is employed to maintain gas pressures in the system.

This is but one of the hundreds of different industrial applications of Frick cooling systems now in operation throughout the world.

No matter what type of cooling is required, there's a Frick-engineered system to fill the bill. Write today for literature and quotations.

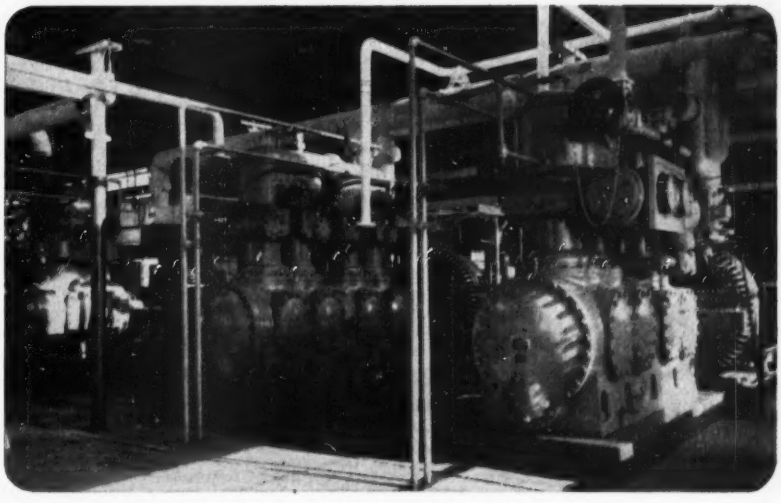
Dealers in Principal Cities Throughout the World

DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA. U.S.A.

Two Frick 4-Cylinder 11" x 10" Ammonia Compressors and a 15" x 10" in Service at Plant.



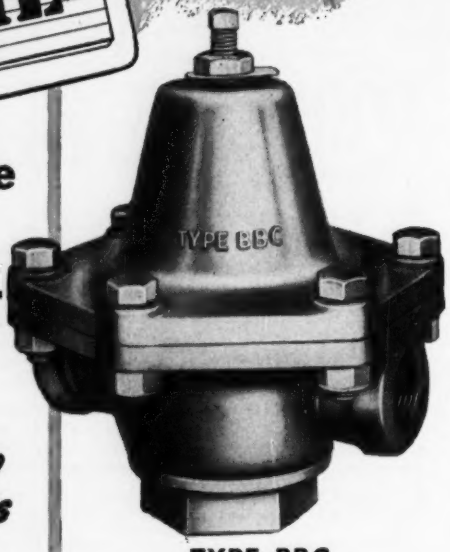
PR & R Valve

with

"UNIVERSAL JOINT" SEATING

For Heavy, Dirty or Viscous Fluids

- Cadmium plated iron or all bronze bodies, monel or neoprene diaphragm, stainless steel renewable piston and seat.
- Standard valve equipped with square head adjusting screw. "T" handle or handwheel also available.
- All working parts easily accessible without removing valve from line.
- **For additional information on Type BBC and other new automatic valves in the Cash-Acme line, write our Engineering Department at the address below. To avoid delay, please include a brief outline of your pressure conditions and requirements.**



TYPE BBC

Pressure Reducing and Regulating Valve

- **NO SMALL PORTS**
- **NO CLOSE FITS**
- **GOOD CAPACITY**
- **IDEAL FOR #6 "BUNKER C" OIL**

Here's a direct acting, single seated, diaphragm-type pressure reducing and regulating valve that automatically reduces a high pressure to a specified lower pressure and keeps it there. Type BBC is for heavy oil service, such as on installations carrying Bunker "C" and other grades, as well as for service on installations where dirty liquids or fluids with a high viscosity are employed. Maximum initial pressure *in iron*, 200 psi; maximum reduced pressure *in iron*, 125 psi. Maximum initial pressure *in bronze*, 250 psi; maximum reduced *in bronze*, 200 psi.

CASH ACME

A. W. CASH VALVE MANUFACTURING CORP.

6627 E. Wabash Avenue Decatur, Illinois

The Complete Cash-Acme Line Includes Pressure Reducing and Regulating Valves, Relief Valves, Back Pressure Valves, Vacuum Regulators and Vacuum Breakers, Differential Pressure Regulators, Strainers, Diaphragm Control Valves.

I—2-54

THIS MONTH'S

Names in

Donald R. Cannon

Chemical Engineering's new assistant editor will take on the responsibility of keeping tabs on new chemical product developments, in addition to his duties in contributing to "What's Happening . . ." and in editing feature articles.

Don joined the CE staff after an eleven year association with Charles Pfizer & Co. He began working for the firm in 1943 as a laboratory assistant, just after graduation from high school. During the next eight years, he earned a Bachelors degree in chemical engineering at Brooklyn Polytechnic Institute while working for Pfizer full time. Gradually, the firm promoted him from his initial assignment to control chemist and production supervisor, in that order. In the latter capacity, Don was in charge of Organic Dept. operations governing antibiotics, vitamins, hormones and fine chemicals—on the 4-12 shift.

George M. Walker—Vice president and general manager of Koppers Chemical Div. For the past two years, Mr. Walker has been engaged primarily in planning and advising on the future growth of the division. He succeeds Dan M. Rugg, who died recently.

Mervin J. Kelly—Recipient of the Industrial Research Institute 1954 medal for "distinguished leadership in industrial research." Dr.

the News

M. A. Gibbons

Kelly, the president of Bell Telephone Laboratories, was cited especially for his "contributions to national security."

William F. Phillips—Assistant manager of the Miscellaneous Chemicals Dept., American Cyanamid Co. Until recently, Mr. Phillips has been a technical sales representative for the firm's heavy chemicals dept. He has been associated with the firm since 1922.

Clifford T. Olsen—Service engineer for the Acheson Colloids Co., Port Huron, Mich. Prior to this appointment, Mr. Olsen, a metallurgical engineer, had been associated with Hanson-Van Winkle-Munning Co. as an electro-chemist.

C. B. Campbell—Chief engineer for the Steam Div., Westinghouse Electric Corp. In his new position, Mr. Campbell will advise the division on all engineering matters. He joined Westinghouse Electric Corp. in 1919 as a technical apprentice following graduation from the University of Michigan.

George M. Bryant—Member of the research and development dept., Carbide & Carbon Chemicals Co. Previously, Mr. Bryant had been with the Textile Research Institute, Princeton, N. J.

G. A. Profita—Regional manager of the mfg. dept., Boiler Div., The Babcock & Wilcox Co. Prior to his appointment, Mr. Profita had been coordinating manufacturing and production activities at the Wilmington, N. C., and Brunswick, Ga., plants of The Babcock & Wilcox Co.

Alfonso Tammaro, John J. Flaherty—Assistant general manager for research and industrial development, and manager of the Chicago operations office, respectively, for the Atomic Energy

SUPERIOR SEPARATOR COMPANY
HOPKINS, MINNESOTA

ENGINEER'S SERVICE REPORT

Engineer G. W. Luger
Address
Town Hopkins
State Minnesota
Date March 15, 1954
Pillsbury Soybean Plant Town Clinton State Iowa

First Report: SUPERIOR "Air Centrifuge" installation at Pillsbury Mills, Inc...

INSTALLATION ☐ SERVICE GUARANTEE ☐ SERVICE CHARGE ☐ MATERIAL CHARGE ☐

NATURE OF WORK First inspection of DC-38A after initial run of 78 continuous 24-hour days.

DETAILS Machine seemed in very good condition with no defects. They were still satisfied with performance and had no complaints. The following conditions were observed after close inspection:

1. 1/8" layer of dust on top inside of machine.
2. 1/16" to 1/32" layer of dust on top of cone-no pattern to film of dust.
3. Bottom of machine inside rotor was clean of all dust except to within 3-4" of screen.
4. Rotor is operating satisfactorily.
5. Cleanout disc clean of material. Clean under cleanout disc.
6. Airlock is clean and free of sticky material.
7. Discharge pipe taking material from centrifuge airlock has a 1 to 2" coating of wet sticky material. This moisture comes from the conveyor into which the solids discharge pipe empties.
8. Inside shell is clean of material.
9. There appears to be no wear on inside of shell after close inspection.
10. Graphite ring and bellows are fairly clean of material. Might have to clean bellows occasionally (6 Mos.)
11. There should be no trouble with bellows and ring.
12. Looking at discharge pipe on roof-no evidence of loss of material.
13. The "V" belts were loose and one fan bearing ran hot.

"...still satisfied with the performance, and have no complaints!"

IN YOUR PLANT, TOO, the unusual new Superior Air Centrifuge may prove to be the answer to many unsolved solids recovery and dust removal problems.

PILLSBURY MILLS, INC. has found the DC-38A Air Centrifuge very satisfactory. H. W. Eikenberry of the Feed & Soy Division writes: *"We placed our DC-38A in operation on Dec. 26, 1953, and operated it continuously for 78 days. During this period we encountered no troubles. Without performing any maintenance, this machine was again placed in operation on March 19, 1954, and has given continuous, trouble-free operation to date."*

THE COMPACT DC-38A is adaptable to plant air flow systems wherever machines such as grinders, pulverizers, dryers, purifiers, solvent extractors, mixers, blenders, etc., are involved. Because it separates by a *patented, impelled-centrifuge principle,* no filters, screens, liquids or electrostatic charges are needed.

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NAMES . . .

Commission. Mr. Tammaro organized the Chicago office in June 1947.

Paul E. Grigg—Ceramic engineer for the Armour Research Foundation of Illinois Institute of Technology, Chicago. Mr. Grigg will be associated with the organic technology section of the Foundation's ceramics and minerals research department.

Dan Schoenholz—Director of the product development department of Foster D. Snell, Inc., consulting chemists and engineers. In his new position, Mr. Schoenholz will be in charge of product development in the field of paints and varnishes.

Henry M. Fisher—Technical assistant to H. J. Eichenhofer, manager of Pennsalt's Calvert (Ky.) Works. After spending two years in research work with Foote Mining Co., Mr. Fisher came to Pennsalt in 1950.

C. E. Morris—President of the American Oil Chemists' Society for 1954-55. Mr. Morris is associated with Armour & Co. as production manager of the firm's refinery. In addition, **W. A. Peterson,** head of the Standardization and Quality Control Div., Colgate-Palmolive Co., was elected vice-president.

John H. Davidson—Member of the staff of Ivan Bloch & Associates. In his new post, Mr. Davidson will specialize in product development and the development of statistical procedures for industry in the Pacific Northwest.

C. A. Butler, Jr.—Director of commercial development for Diamond Alkali Co., Cleveland, Ohio. Since 1946, Mr. Butler has been director of engineering for the firm. In the latter capacity, he is succeeded by **Loren Scoville.**

John G. McLean—Assistant to the president of Continental Oil Co., while on leave of absence from

Harvard University. This nationally known authority on industrial organization is a professor of business administration at the Cambridge school.

Bernard Kearney—President of the Torsion Balance Co., Clifton, N. J. The firm manufactures a line of balances for prescription weighing and analytical balances for industrial laboratories.

Harry A. Bright—Recipient of the Dept. of Commerce Silver Medal for Meritorious Service. The award was made for "outstanding contributions in the general field of inorganic analysis . . ." At present, Mr. Bright is chief of the analytical chemistry section of the National Bureau of Standards.

Oliver W. Cass—Recipient of the 1954 Jacob F. Schoellkopf Medal of the American Chemical Society, Western N. Y. section, for his work in developing the process for the production of adiponitrile from furfural. Dr. Cass is assistant laboratory manager of the Du Pont Co.'s electro-chemicals dept., Niagara Falls, N. Y.

William J. Welch—Vice-president of National Lead Co. and a member of its executive committee. Mr. Welch, associated with the firm largely since 1916, is a director of the company and manager of its metal dept.

Paul R. Schultz—Manager of chemical plants for Stanolind Oil & Gas Co., Tulsa, Okla. Other appointments include Larry L. Smith, superintendent, chemical plants; Gilbert F. Moore, operating superintendent, chemical plants; and Duane W. Farnham, synthesis plant superintendent.

Howard F. Bjork—Vice president of manufacturing for Sharples Chemicals, Inc. Mr. Bjork has been associated with the firm for the past 17 years. Since 1950, he has held the position of plant manager. Another appointment made **Howard I. Cramer** vice president of development.

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The capacity of this pump is determined by the "*pitch*" *of the screws* and the full load speed of the motor. Expert engineering knowledge of just the right pitch, number of threads, experience data, and precision workmanship are all mighty important in this highly specialized type of pump. It is available in two general types:

Gear-in-head, with internal gears and bearings, for handling lubricating liquids free of corrosive elements and solids.

Double External Bearing and Gear, with separately lubricated gears and bearings, for handling all other liquids.

Standard pumps include jacketed, unjacketed, horizontal, vertical pedestal, vertical bulkhead, long body and hopper types in all machinable metals. Capacities, up to 3000 g.p.m. and pressures up to 700 p.s.i. on low viscosity liquids, and practically unlimited for high viscosity liquids which will flow into the pump inlet.

For specialized services involving hard-to-handle materials, insist upon Warren-Quimby, the original Screw Pump . . . now owned, greatly improved, manufactured, serviced and guaranteed by Warren . . . one of the pioneers of the Pump Industry.

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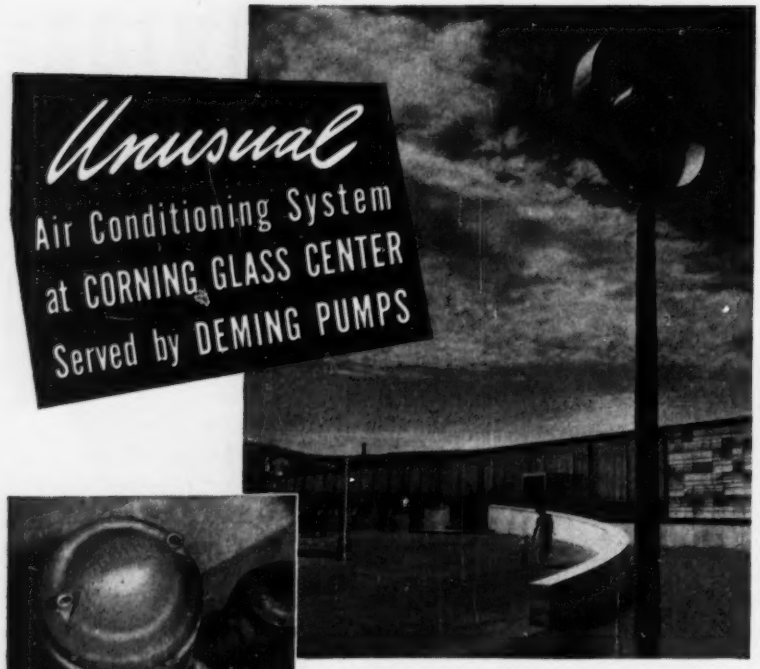
Warren, Massachusetts



Above view shows main entrance of the Corning Glass Center, established in 1951 by the Corning Glass Works at Corning, N. Y.

View at left shows the Deming Vertical Turbine Pump which serves the versatile air conditioning system at the Corning Glass Center.

Dedicated to the history, art and science of glass-making, the Corning Glass Center at Corning, N. Y., has been visited by more than a million people since its official opening in 1951. Maintaining proper temperatures throughout its multiple units requires an extremely versatile and flexible system of air conditioning. Cooling loads are unusually high and variable due to the glass walls, absence of shade, and constantly changing numbers of people in the numerous units of the Center.

A Deming Vertical Turbine Pump supplies water from a 100-foot well to the condensers. A system of chilled water circulated to conditioning equipment for each area or group of areas is used. Loads total approximately 300 tons and require circulation of an aggregate of approximately 100,000 CFM of conditioned air.

For complete information about the applications of Deming Vertical Turbine Pumps in air conditioning systems and for many other uses, write for Bulletin 4700.

THE DEMING COMPANY
525 Broadway • Salem, Ohio

Deming
VERTICAL TURBINE PUMPS

THIS MONTH'S

Man of

Harry B. McClure

New president of Carbide and Carbon had a hand in the commercial development of some 200 synthetic organic chemicals.

Right back where he started from. That's the spot in which Harry McClure found himself when he took over the presidency of Carbide and Carbon Chemicals Co. recently.

Don't get me wrong though, he wasn't president once before. It's just that some 26 years ago when he was first hired by Carbide the hiring took place in the same office he now occupies as president. Those 26 years between his first and his latest trip to that office have been years of achievement for both Harry McClure and Carbide and Carbon.

Harry's name first appeared on a Carbide payroll back in 1928, when he accepted a research fellowship for work at the University of Pittsburgh's Mellon Institute of Industrial Research. He had received his BChE from the University of Pennsylvania four years before and had remained at Penn as an instructor in inorganic chemistry while working toward a master's in chemistry. That achieved, he joined Carbide.

After winding up work at the institute, Harry moved back to Philadelphia to become the company's

the Month

H. T. Sharp

technical representative in that area. Here his penchant and enthusiasm for sales work was nurtured and developed.

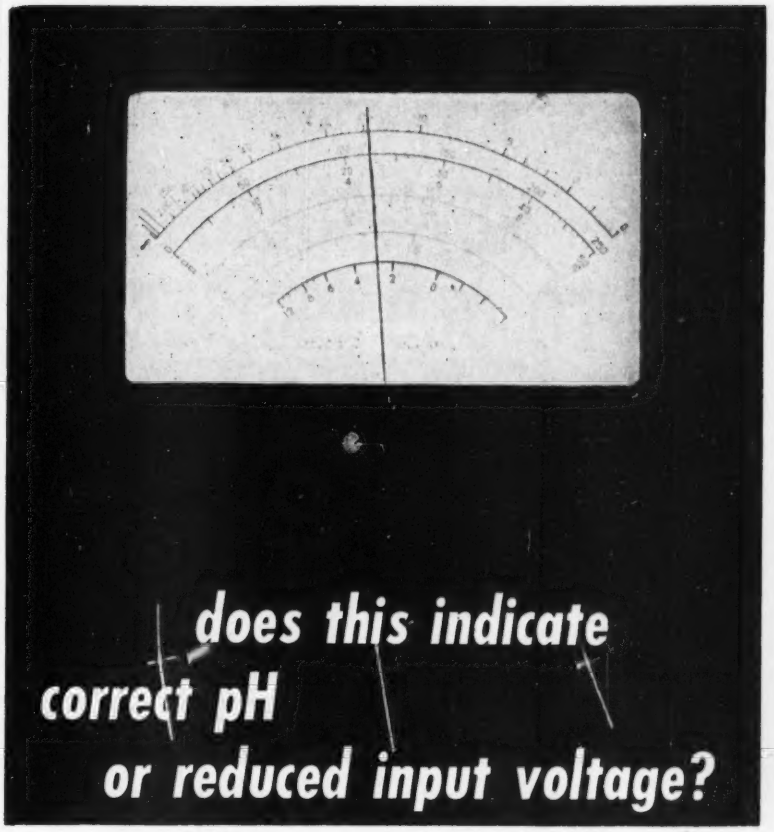
And it wasn't too long before he was brought up to the New York office and assigned to sales development work. His efforts here were devoted principally to the development of markets and uses for the many new products pouring from the company's research laboratories.

As a number of these attained commercial status, the company saw a need for a new division, and in 1936 Harry helped organize the Fine Chemicals Div. A year or so later he became its manager. This job involved overseeing the development of both production processes and markets and uses for the products.

In 1944 he was made a vice-president of the company and just last year became executive vice president. Further honors came his way when in 1948 Morris Harvey College conferred on him an honorary D. Sc. degree. And when, in 1950, Harry was selected as the first recipient of the Commercial Chemical Development Association's Honor Award.

It's no accident that Harry McClure has spent the biggest part of his professional life connected with sales development. His is one of those inquiring minds—always questioning, always eager to learn—necessity for the constant search for new uses and new markets for products. How well that inquisitive mind works is illustrated by the fact that in his career with Carbide the new president has had a hand in the commercial development of some 200 synthetic organics—helped many of them grow from mere laboratory curiosities to full-fledged, tank-car-shipped staples.

Of course, he's had lots of help—a goodly portion of it from his wife and two children. For years it's been his practice to take home products which are either Carbide-made or which incorporate a Carbide-made material in their make-up and spring them on the Mc-



Many experiments — colorimetric analysis, gas analysis, and others — are complicated unnecessarily by poor voltage. Under erratic line voltage conditions, reliable instruments may give readings that indicate voltage changes rather than measurements of substances being tested.

The chemist whose work is hampered by unsteady line voltage will do well to purchase a Sorensen electronic AC regulator, such as the model 150S illustrated herewith. This regulator controls voltage to ±0.1% with *good waveform*. Waveform is extremely important, since most laboratory instruments require a clean 60-cycle sine wave input in order to function properly

In addition to giving close regulation with good waveform, the Sorensen regulator is dependable, trouble-free, reasonably priced. Instruments are available in a wide range of capacities to meet widely divergent needs; there are also extremely precise regulators accurate to ±0.01%.

Sorensen instruments employing similar circuitry are widely used in science and industry to supply regulated DC in high and low voltages, very heavy current for plating and electrolytic processes, and with very precise regulation for powering spectrophotometers. Write for full information to Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn.

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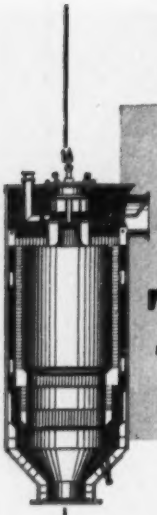

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Write for Bulletin 600-E

NAMES . . .

Clure family. The products would then be put to a rugged "at home" test in actual day-to-day use.

"The family," Harry reports, "are the severest critics—and sometimes the most enthusiastic fans—that the products will ever have. When they put a final okay on something I know it must be good."

Incidently, if enthusiasm of the family is a measure, then sailing on the Long Island Sound is a fine family recreation. From spring til fall the McClure's 24-ft. sloop is on the water. Only trouble is that for the past few years Harry himself hasn't been able to get out too often—at least not as often as he would like to—"but the kids sure er joy it."

His golf game also has suffered as he took on more and more responsibility, and now he finds that one of his biggest sources of "recreation" is "doing the reading that I can't find time to do at the office."

Ralph A. Troupe—Research professor of chemical engineering at Northeastern University. In his post, he will direct industry-sponsored research work in corrosion and engineering materials.

Fred J. Watt—Manager of the newly combined section of Worthington Corp.'s air conditioning and refrigeration div. at the firm's executive offices in Harrison, N. J. The new section will known as the central station and ammonia equipment section.

J. Harrahill—Plant manager of the new Lancaster, Pa., factory of the Permutit Co., N. Y. Mr. F. K. Richardi has been appointed his assistant. Mr. Harrahill has been associated with the firm since 1947. Since 1951, he has served as plant manager for the Simplex Valve & Meter Co., a subsidiary of Permutit.

Hugh Glen—President of Johnston Pump Co. He succeeds Mrs. Thomas W. Simmons, sole owner of the firm, who has resigned the presidency. Formerly,

Mr. Glen was president of Emsco Derrick & Equipment Co.

Frank F. Hohnholt—Manager of the Water-Tube Steam Generator Div., Superior Combustion Industries. Formerly manager of Package Generator Sales for the Foster Wheeler Corp., Mr. Hohnholt has had wide experience in the engineering and sales of packaged boilers.

Seymour Weinstein—Technical director of Niagara Filters Div., American Machine & Metals, Inc. Previously, Mr. Weinstein has been associated with National Aniline, Div. of Allied Chemical & Dye Corp. He joined Niagara Filter in 1945.

Frederick M. Murdock—Assistant director of the patent dept., Monsanto Chemical Co. Mr. Murdock, who has been in charge of patent work for the firm's organic chemicals div. since 1949, joined the Fiberloid Co. in 1932 before it was acquired by Monsanto.

J. B. Saunders Jr.—Vice president of Texas Eastern Transmission Corp. Active in the oil business since 1922, Mr. Saunders organized Triangle Refineries, Inc., in 1937. The latter firm is the largest independent marketing organization for petroleum products in the U.S.

Floyd D. Vermilya—Has been admitted to partnership in Sanderson & Porter. Since he came to the firm in 1942, Mr. Vermilya has worked on steam and hydroelectric power projects, chemical and industrial boiler plants and distilleries.

Ralph E. White—Divisional general manager, Container Corp. of America, shipping container plants in Indiana, Ohio and the Eastern states. David R. Riggs has attained a similar appointment for the firm.

J. P. Van Gelder—District manager of the Oakland, Calif., district,

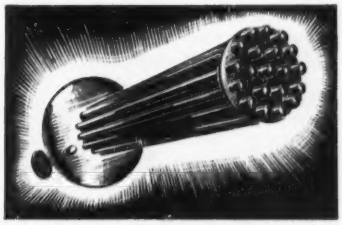
Nothing is "just as good as" TANTALUM Nothing can be substituted for it

Don't compare Tantalum, *analyze* it! A study of its excellent properties—immunity to corrosion—high thermal efficiency, high tensile strength, ductility, puts Tantalum in a class by itself. No other material comprises all its advantages.

These *inherent* advantages of Tantalum have introduced new economy and efficiency to many chemical processing operations. An excellent heat conductor, Tantalum saves steam or cooling water, permits closer process controls. As a metal with high tensile strength and easy ductility, Tantalum allows light gauge construction; eliminates breakage as well as expensive framework and supports. And because Tantalum is acid-proof, it eliminates many of the costs of corrosion such as product contamination, equipment repair and replacement, shutdowns, etc.

These economies and others are possible with Tantalum. Call in an experienced Fansteel engineer to tell you, quickly, whether or not they can be effected in your processing operations.

Use Tantalum with economy for most acid solutions and corrosive gases or vapors except HF, alkalis, or substances containing free SO_3.



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Now you can have the advantages of USCOLITE* in your valves as well as in your piping

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Developed to supplement Uscolite* pipe and fittings, the new Uscolite bodied Hills-McCanna Diaphragm valve, now makes it possible to utilize Uscolite's advantages throughout your piping layout. The unique Saunders patent design of the valve coupled with the chemical resistance of Uscolite makes the valve ideal for plating, water treatment, and in the manufacture of fertilizer, bleach, storage batteries, pulp and paper, etc.

The Hills-McCanna Uscolite bodied valve is available in standard sizes from ½" through 2". It is suitable for pressures to 150 psi and for temperatures to 170° F. (at some sacrifice of pressure rating in larger sizes).

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- Working parts isolated from flow.
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NAMES . . .

United States Gypsum Co. Formerly, Mr. Van Gelder had been assistant merchandising manager of the firm's plastering products division.

Harry E. Lewis–General manager of the Insulation Div., M. H. Detrick Co. In this capacity, Mr. Lewis will be responsible for planning and directing the Div.'s operations in U. S. foreign and Canadian markets.

William T. Mahood–Manager of the contractors section, Atlas Powder Co., Explosives Dept. In adidtion, George Gabuzda has been named manager of the development and standards section for the dept's manufacturing div.

F. F. Ogden–Assistant director of development, Monsanto Chemical Co., Plastics Div. In his new appointment, Mr. Ogden will have a key positon in the firm's $1¼ million program–a result of the integration of the firm's development and technical service functions.

Thomas R. Young, Harlow J. Reed–Newly elected partners of the firm of Singmaster & Breyer. A chemical engineer, Mr. Young has been with the firm for 9 years. His experience covers operations in heavy and fine chemicals, electrolysis, and extractive metallurgy.

Schuyler T. Tylee–President of Jacques Wolf & Co., manufacturing chemists. The firm is a major supplier of chemical products for the textile, leather, food and allied industries.

Russel G. Allen–Executive vice president of the Godfrey L. Cabot, Inc., Boston, Mass. Mr. Allen joined the organization in Texas in 1925. In 1930, he was placed in charge of the south western div., in Pampa, Texas.

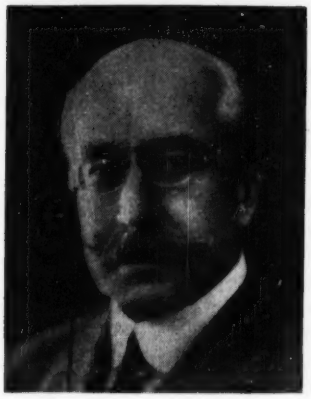
William P. Gee–In charge of all Texaco petrochemical activities. Mr. Gee, assistant to President Augustus C. Long, will be re-

sponsible for the firm's activities in the field of synthetic rubber. The appointment is a preliminary step in Texaco's proposed expansion program.

Thomas A. Printon—Chairman of the Board and president of Nopco Chemical Co. In the former appointment, he succeeds Charles P. Gulick—now Honorary Chairman of the Board. Mr. Printon has been with Nopco since 1922 and president since 1949.

William R. Moffitt—Vice president and technical director of Borden Co.'s Chemical Division. Formerly, Mr. Moffitt has been manager of the Div.'s West Coast operations, with headquarters in Seattle, Wash.

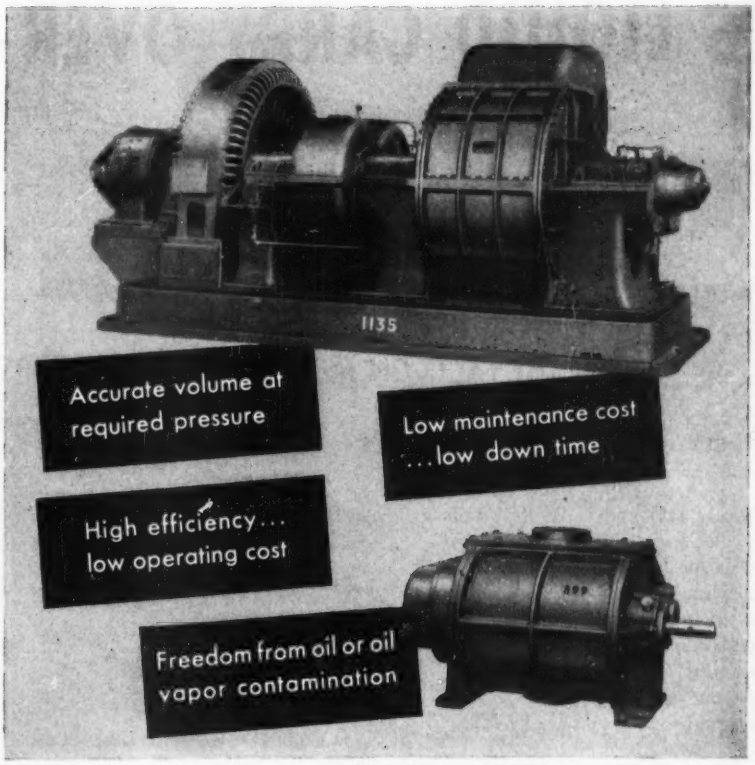
OBITUARIES



M. T. Bogert

Professor emeritus of organic chemistry at Columbia University and an internationally known authority on synthetic organic chemistry, Dr. M. T. Bogert died March 31 at the age of 85.

Although his work covered a wide field, he was particularly known for his research on synthetic perfumes. An intensive study on essential oils resulted in his receiving a grant awarded by the American Manufacturers of Toilet Articles. During World War I, he headed the Chemical Warfare Service of the army with the rank of colonel; and, during the last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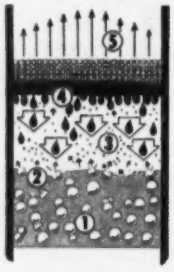
Section of a METEX MIST ELIMINATOR, opened to show construction. Factory cut to fit vessel dimensions and contour, there is no limit to the size in which they can be obtained. They can be made of practically any metal, to combat corrosion.

These separators, which are made from layers of knitted wire mesh, literally "filter out" the liquid droplets by impingement and accumulation in depth (see diagram). The liquid is returned by gravity: The gas passes on freed from the unwanted—and often contaminating entrainment.

METEX MIST ELIMINATORS can be easily installed in new or existing vessels. Special housings are not needed, and they have no moving parts to require power and servicing. They will function over an unusually wide range of velocities with a pressure drop generally well under 1" of water. Efficiencies of 99% and over are commonly reported.

While liquid entrainment is an inevitable result of practically any processing operation involving the handling of liquids and gases together, it need no longer be considered as an unavoidable evil. It can be controlled simply, effectively and economically – by a Metex Mist Eliminator, as more and more engineers are finding from experience.



When a gas is generated in or passes through a liquid (1) it carries with it on leaving the surface (2) droplets of entrained liquid. These droplets are carried upward by the rising gas stream (3). As the gas continually changes direction in passing through the pad, the droplets are impinged on the extensive wire surface. Here the droplets coalesce, forming large drops of liquid which break away (4) from the pad and fall back through the gas stream. The gas (5) passes on, freed from liquid entrainment.

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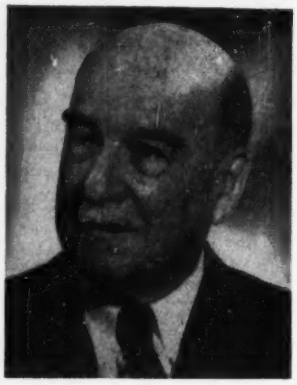
NAMES . . .

war, he served in the chemical industry branch of the War Production Board.

He had been affiliated with nearly every major professional organization in the chemical field at some time during his career. From 1938-1947, he was president of the International Union of Chemistry. Twice president of the American Chemical Society, he was also the winner of the Priestley gold medal.



Pierre S. du Pont

One of the nation's foremost industrialists and head of the du Pont family died unexpectedly, on April 5, at the age of 84. Pierre du Pont's lifetime spanned the whole period of America's modern industrial development, and growth to maturity.

At the turn of the century, Mr. du Pont acquired the E. I. du Pont de Nemours & Co., with his two cousins, Alfred I. and T. Coleman du Pont. They began a transformation of the company, already 100 years old, from a manufacturer of black powder to one of the greatest chemical enterprises in the world. Although he had resigned from the official position as chairman of the Board of Directors in 1940, Mr. du Pont continued to serve as a director and a member of the Finance Committee. His desire to continue serving as long as he was able is typical of the industry with which he worked during the period of the firm's greatest diversification and development.

Shortly before his death, he was made a commander of the Legion of Honor of France. In social re-

form, his philanthropies amounted to millions of dollars and were especially noteworthy in the field of education.

Walter R. Nay, Chicago regional manager of Mallinckrodt Chemical Works, drowned on April 6, in Florida, soon after the American Pharmaceutical Mfg. Ass'n meeting. He had been active in the chemical and drug field and had been president of the Chicago Perfumery Soap and Extract Ass'n during 1946.

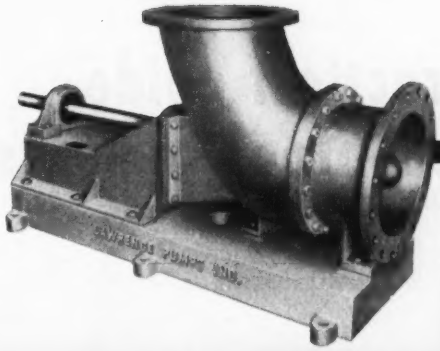
Arthur C. Mengel, chief chemical engineer of the American Locomotive Co., died suddenly on March 20 of a heart attack. He had been chiefly concerned with testing procedures involving both locomotive lubricants and with the solution of corrosion problems.

G. W. Bach, chairman of the board of the American Sterilizer Co., died on March 13. He had been president of the firm until his illness made it necessary for him to relinquish the position.

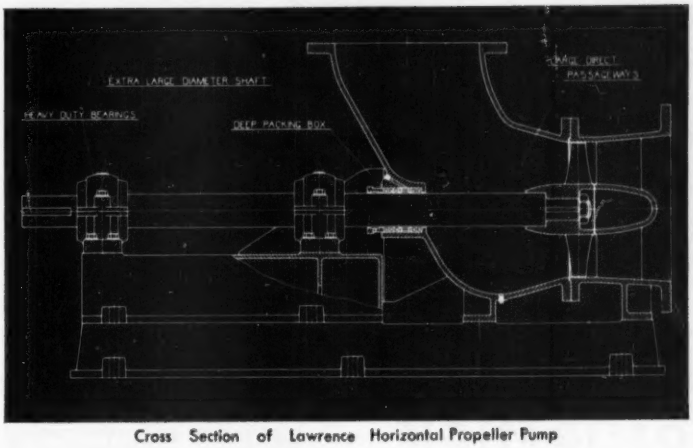
Karl M. Leute, president of Lithium Corp. of America, Inc., and president of Manganese Chemicals Corp., died on March 24 in Phoenix, Ariz. He had organized the Electro Manganese Corp. in 1937, and in 1942 he founded the Metalloy Corp. (later Lithium Corp. of America).

Dan M. Rugg, vice president of Koppers Co., Inc. and general manager of its chemical division, died March 28 in Pittsburgh. Besides his work in expanding the activities of the division, he had been noted for his services in building up the nation's synthetic rubber production during World War II.

Henry Duckworth, associated with the Norton Co., Worcester, Mass., for more than 60 years, died April 1, in Palm Beach, Fla. He retired as a vice president last year. During his long association, he had been active in promoting employee benefit programs.



Lawrence 24" Horizontal Circulating Pump of Nickel Alloy Construction



Cross Section of Lawrence Horizontal Propeller Pump

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Lawrence Propeller or Axial Flow Pumps are widely used to circulate large volumes of liquid or slurry against low heads as in evaporators, crystallizers, etc. This type of pump is particularly well adapted for circulating service because of its simplicity, high efficiency, and low first cost. The flow can be arranged in either direction and the casing turned to any position desired to serve as an elbow. The capacity can be closely regulated by varying the speed—very important in crystallization processes where a uniform velocity must be maintained.

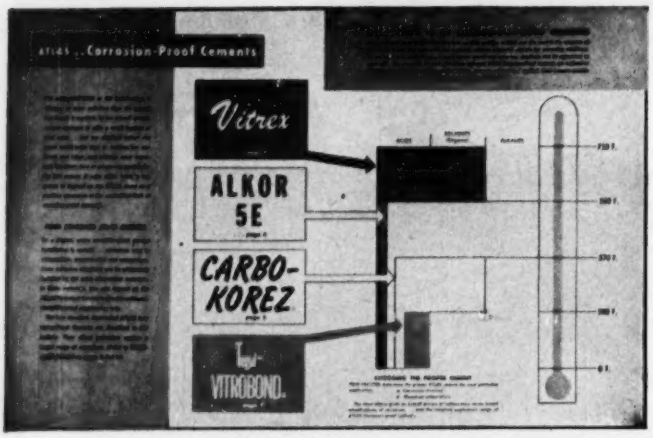
Lawrence Propeller Pumps are made of the metals and alloys best suited for their ability to resist the corrosive and abrasive action of the liquid pumped.

Write for Bulletin 203-6 for summary of acid and chemical pump data.

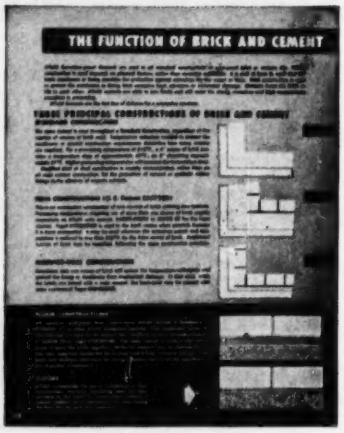
LAWRENCE PUMPS INC.

371 MARKET STREET, LAWRENCE, MASS.

. . . a practical guide to Corrosion-proof cements



NEW, INFORMATIVE BULLETIN AVAILABLE WITHOUT OBLIGATION



HERE in concise form you will find complete data on the basic types of corrosion-proof cements and constructions. Each cement is graphically shown in its relationship to temperature and the broad classes of corrosives handled.

In addition, RESISTANCE TABLES are included which cover 176 common corrosives, and relate them to cements satisfactory for that service. And, ESTIMATING TABLES guide you in figuring not only cement, but also brick requirements for most corrosion-proof construction jobs.

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ATLAS MINERAL PRODUCTS COMPANY

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ATLAS PRODUCTS STAND . . . between your process and corrosion.

Corrosion-proof: Cements . . . Coatings . . . Linings

THIS MONTH'S

Letters:

Come on up . . .

. . . but you'll have to climb!

Reach the Top?

Sir:

I'd like to tell you how much I enjoyed that little piece in your April issue (p. 234) on "How to Reach the Top . . ."

It was readable, thoroughly enjoyable, full of common-sense advice. I particularly liked the frank implication carried in the second half of the title ". . . If That's What You Really Want."

Not everybody, as you point out, is willing (or able) to pay the stiff price for the privilege of sitting precariously on that top rung. And I'm tired of hearing the pompous preachings of some of the big names in our own profession who try to lead us to believe otherwise. About 95 percent of these authors assume that every engineer can become a vice president some day. . . .

Keep up the good work with

Pro & Con

your You & Your Job department . . . I'll take it first evety time!

RAYMOND A. MAGILL

Design Engineer
Knoxville, Tenn.

► *Hugh Sharp, author of "How to Reach the Top . . ." and editor of our You & Your Job department, feels strongly about "pompous preachings" —almost allergic, some people say. So you're not likely to see much of it in You & Your Job. Not as long as Hugh's around.*—ED.

Salute to Strube

Sir:

Congratulations on the very practical, comprehensive and useful report "Conveyors & Elevators" by Harry Strube in your April issue (pp. 195-210). It is the best treatment of this subject that I have yet seen . . . please send me 15 reprints, which I wish to distribute among some of my associates. . . .

HAROLD ZINGALE

Consulting Engineer
Elizabeth, N. J.

► *Harry L. Strube, author of this 16-page report on conveyors and elevators, is a well-known materials handling engineer. He has spent most of his professional life in the field. Mr. Zingale's letter reflects the favorable comments coming from CE readers throughout the chemical process industries.*—ED.

Vacuum Cooling

SIR:

We refer to the milk of lime cooler illustrated and described in the article "How to Check Your Jet Utilities" in your January issue, pp. 161-164. This company designed and built that particular unit for Texas City Chemical Co.

This unit cools in two stages. In the first stage the milk of lime is flashed to the minimum temperature which is practical when condensing the vapor direct in the barometric condenser. The partly cooled milk of lime then flows by gravity into a second flash cooling chamber where the vapor is com-

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are recommended for installation — today — before uncontrolled tramp iron is allowed to play havoc with your equipment. PRATER PERMANENT MAGNETS, readily attached to hoppers, spouts or chutes, reach deep into the flow to weed out these destructive metals, increase operating efficiency and safeguard life and property. Each installation is specific as to type, size and arrangement of magnets, as specified by your requirements. Write for details.
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PRATER

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A well-rounded tube maintenance program employing the regular use of Airetool Tube Cleaners and Tube Expanders, plus the Airetool Tube Expansion Control System, will keep any plant at peak efficiency and economy, and eliminate costly downtime due to tube failure. Powerful, high-speed cleaners quickly remove even the hardest deposits from straight or curved tubes. Tube joints are rolled tightly and accurately with maximum bond when Airetool Tube Expanders are used, while the unique Airetool Tube Expansion Control System cuts, in half, the time needed to overhaul or retube a bundle.

Airetool Cleaner Heads, precision made from special heat treated alloy steel, quickly and thoroughly remove any type of foreign deposit from tubes. The P-type head shown is only one of many Cleaner Head types available.

Airetool Tube Expanders are made from the best alloy steel; correctly designed, precisely machined, and heat treated for enduring service. Parallel rolling and self-feeding, they will produce uniform expansion and tightness throughout the full thickness of the tube sheet.

The Airetool Automatic Tube Expansion Control provides uniformly tight joints, with no over or under expansion . . . giving increased tube end life, and eliminating fracture or distortion of tube sheet ligaments. Tube bundles may be rolled to pre-determined maximum tightness at production line speed — precision electrical control automatically shuts off power at point of maximum bond.

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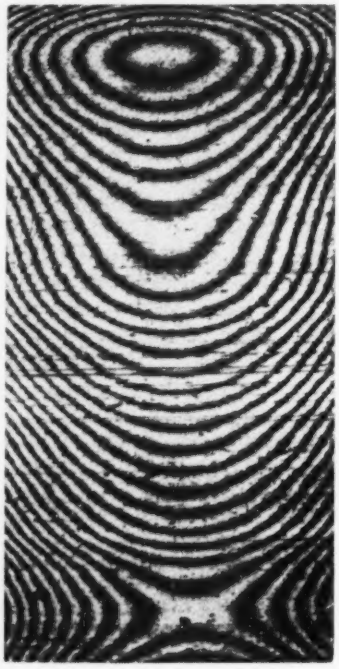
THERE'S AN AIRETOOL TUBE EXPANDER OR TUBE CLEANER FOR EVERY TYPE OF TUBULAR CONSTRUCTION.

PRO & CON . . .

pressed in a 16-in. jet vacuum pump. This discharges to a second barometric condenser which uses the discharge water from the 1st-stage condenser.

D. H. JACKSON
Croll-Reynolds Company, Inc.
New York, N. Y.

► *This company also produces similar types of vacuum cooling equipment now being used extensively for rayon spin bath liquors, production of cellophane, pulp bleaching operations and other applications in the chemical process industries.*—ED.



Worn Drawtwister Ring

Sir:

In my article "How to Use Micro-Interferometry as a New Engineering Tool" in March, an error occurs on p. 217 in referring to the last illustration. . . .

This picture shows conditions at the edge of a spinneret orifice instead of wear in a drawtwister ring as indicated.

R. E. SUGG
Mechanical Development Lab.
Engineering Dept.
E. I. duPont de Nemours & Co.
Wilmington, Del.

► *We got our signals mixed and con-*

fused the edge of a spinneret orifice with a worn drawtwister ring!

The above illustration of the drawtwister ring shows the unusual versatility of the micro-interferometer. Relative wear between the high spot (top) and the low spot (bottom) is about 245 micro-inches.—ED.

Depreciation and Costs

Sir:

The February issue of *Chemical Engineering* contained two articles on depreciation and costs. Although each used a different approach, both contained errors.

Hartogensis and Allen state "The age at time of study multiplied by the annual depreciation is the amount which should be in the depreciation reserve at any given time."

Their example provides for $500 per year to be placed in a fund for 20 years to replace a filter press costing $10,000. They make no allowance for the fact that money has value and the going interest rate should be considered. At an interest rate of 4 percent compounded annually, it's necessary to deposit only $335.80 at the end of each year for a 20-year period to obtain a sum of $10,000.

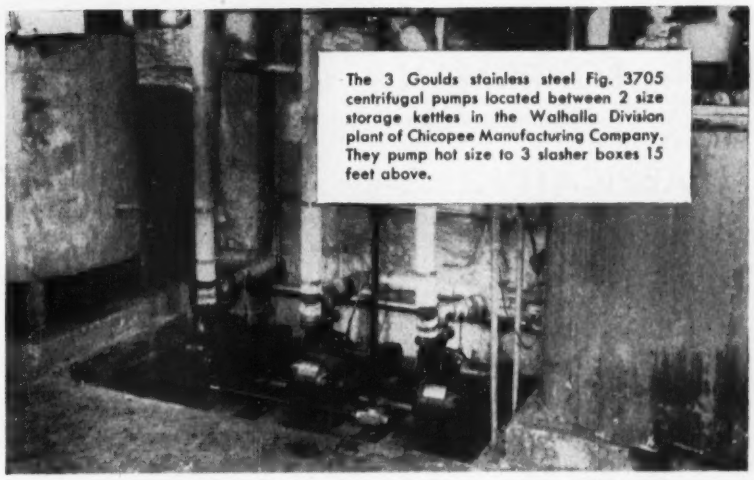
Jelen makes use of an unwieldy concept of "capitalized cost." By so doing the solutions to his problems are erroneous.

In the sample problem dealing with condenser tubes costing $10,000 and lasting 6 years, $1,507.60 per annum at 4 percent interest will provide the replacement capital. It is unnecessary to become involved with fictitious sums. An initial sum of $10,000 is required for condenser tubes. If $1,507.60 can be put aside at the end of each year at 4 percent the sum of $10,000 will be available when required.

The solutions to the problems on p. 200 should be obtained in the manner outlined below. This procedure is based upon good practice as described in "Principles of Engineering Economy" by E. L. Grant (Ronald Press).

Problem 1

Where S is $15,000 and n is 2 years and the sinking fund factor is 0.49020, then



The 3 Goulds stainless steel Fig. 3705 centrifugal pumps located between 2 size storage kettles in the Walhalla Division plant of Chicopee Manufacturing Company. They pump hot size to 3 slasher boxes 15 feet above.

Stainless steel pumps economize handling of hot, sticky size

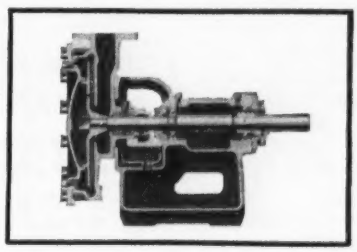
The sticky, glutinous size used to "fill" such fabrics as print cloths and sheeting poses a tough problem in liquid handling.

It must be handled hot (over 200° F.), and that's rough on pump packing and parts. All in all, it's just a disagreeable material to work with.

The Chicopee Manufacturing Company's Walhalla Division, weavers of many "filled" fabrics, maintains a constant 24-hour-a-day flow of hot size with three Goulds Fig. 3705 stainless steel pumps.

In the more than 3 years these pumps have been in operation there has been no replacement of parts, and what used to be a weekly job—repacking—has been eliminated. Loss of size through leakage at the pump also has been stopped.

Just as Goulds Fig. 3705 stainless steel pump is designed for exacting chemical service, there's a Goulds pump for practically every industrial pumping need. The experience and knowledge of Goulds engineers, with a background of 107 years of pump manufacturing to draw on, is available to you. Let us help you make sure of getting the pump that matches your specific requirements. Just drop a line to GOULDS PUMPS, INC., Seneca Falls, New York.



Cross-section of Fig. 3705 pump showing how stuffing box is subjected to suction pressure only. Impeller can be cleaned, or removed and replaced, without disturbing piping connections. For additional details ask for Bulletin 725.3.

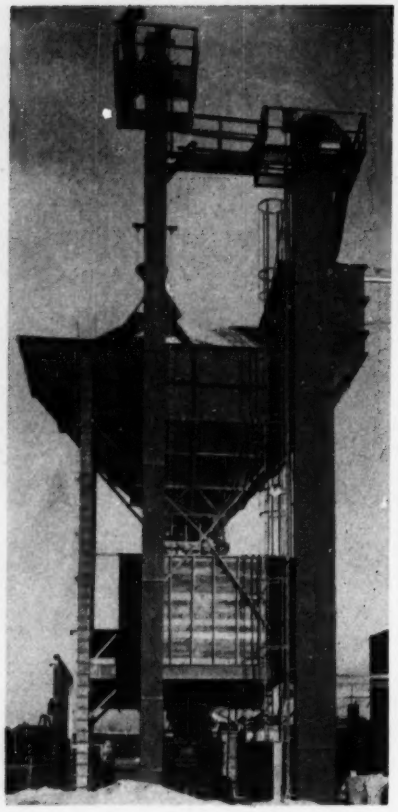
MEMBER

Goulds PUMPS INC.

Seneca Falls New York

BOARDMAN MILD STEEL FABRICATING . . .

ON THE JOB



Here you see a cement mixing plant fabricated of mild steel by The BOARDMAN Co. This unit took shape on a drawing board in BOARDMAN'S own engineering department. From there the more than 44 years of BOARDMAN metalcrafting experience went to work. Each detailed unit was precision fabricated to fit perfectly into place. Field erection was made a relatively simple matter. You'll find there are no misfits on a BOARDMAN fabricated job.

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PRO & CON . . .

$R = \$15{,}000 \times 0.4902 = \$7{,}353$

If a sum of $7,353 is deposited at the end of each year the $15,000 anodes can be replaced every second year.

If n' is 7 years, R' is $7,353 and the compound amount factor is 7.898, then

$S = \$7{,}353 \times 7.898 = \$58{,}074$

If the special anodes cost $58,074, the sum of $7,353 deposited at the end of each year will replace the special anodes every seventh year. Therefore, we can afford anything less than $58,074. Note the article states $47,740.

Problem 2

If S is $8,000 and n is 12 years and the sinking fund factor is 0.06655, then

$R = \$8{,}000 \times 0.06655 = \$532.40$

If n' is 3 years and compound amount factor is 3.122, then

$S' = \$532.40 \times 3.122 = \$1{,}662.15$

We can spend up to $1,662.15 for patching the existing tank. This is equivalent to the annual amount of $532.40 which must be set aside to replace the $8,000 tank. Note the article states $2,366 can be spent for patching.

Problem 3

If S is $5,000 and n is 2 years and the sinking fund factor is 0.49020, then

$R = \$5{,}000 \times 0.4902 = \$2{,}451$

If $2,451 is deposited at the end of each year the $5,000 floor can be replaced every second year. S' is $16,500:

If n' is 6 years, the sinking fund factor is 0.15076 and R is $2,487.54.

If n' is 7 years, the sinking fund factor is 0.12661 and R is $2,089.07.

The more resistant floor need last only 6.1 years to justify the larger expenditure. Note the article's calculations require about 7.1 years.

S represents a sum of money n interest periods hence which is equivalent to P with interest rate i; P represents a present sum of money; R represents the end of period payment in a uniform series continuing for n periods. (The en-

tire series equivalent to P at interest rate i).

$S = R[(n + i)^n - 1/i]$
$= R \times$ compound amount factor.

$R = S[i/(1 + i)^n - 1]$
$= S \times$ sinking fund factor.

FRANK L. RUBIN

Catalytic Construction Co.
Philadelphia 2, Pa.

► *Author Jelen answers Mr. Rubin in the letter that follows immediately. Authors Hartogensis and Allen answer Mr. Rubin's points in the letter that follows that of Jelen.*—ED.

Pro: Capitalized Costs

Sir:

Mr. Rubin's method of calculation for comparing alternate systems is incorrect. He has made an error of omission, forgetting to include the interest on the initial investment. He considers only the annual cost necessary to perpetuate the system *after* the first cost has been made.

Example 1 of the article showed that if anodes cost $15,000 and last 2 years then up to $47,740 could be spent for special anodes that last 7 years, with money worth 4 percent.

According to Rubin up to $58,-074 could be spent for special anodes, based on the following reasoning:

The $15,000 anodes could be replaced by making end-of-year payments of $7,353 to a sinking fund, for at the end of 2 years $15,000 would be available for the replacement. (Note that $7,353 yearly includes no cost for the $15,000 put up for the initial investment.)

For the special anodes which last 7 years $58,074 could be spent because end-of-year payments of $7,353 would amount to $58,074 at the end of 7 years and thus provide the replacement.

Briefly, then, Rubin says that the two following choices are equal:

(1) Pay $15,000 for regular anodes and then pay $7,353 yearly to perpetuate the system;

(2) Pay $58,074 for special anodes and then pay $7,353 yearly to perpetuate the system.

Obviously the two are far from

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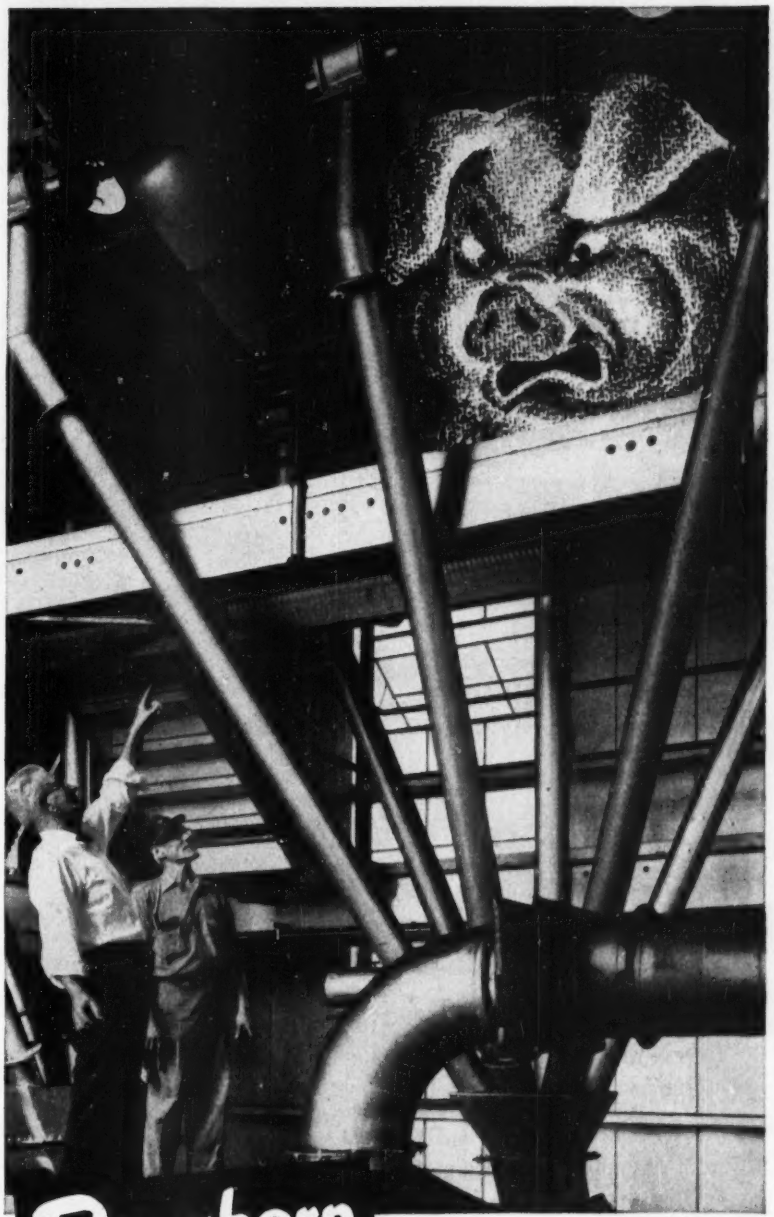

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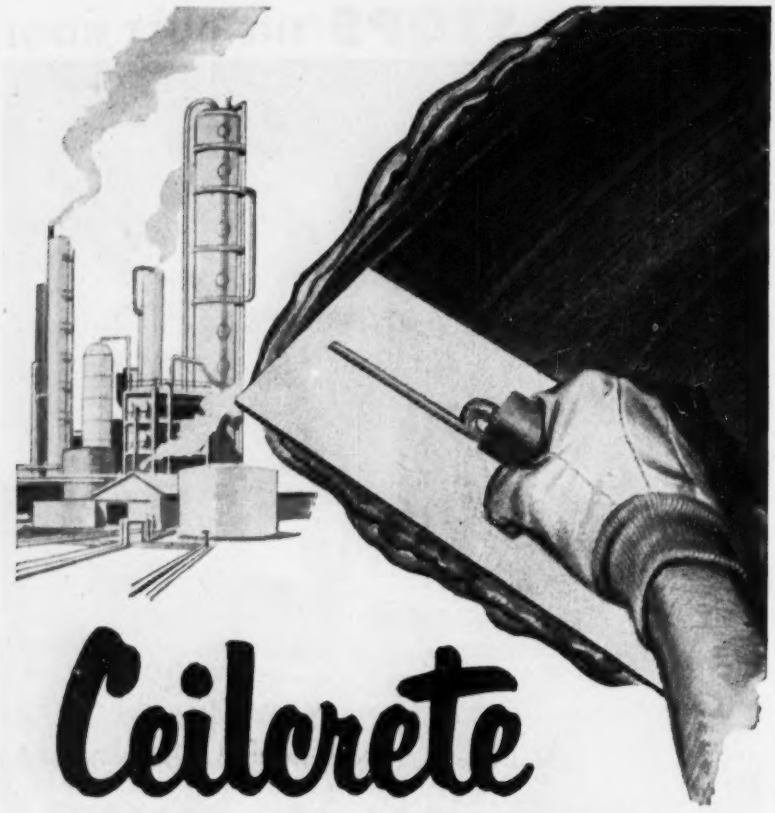

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1859-CC

THE CEILCOTE COMPANY
CORROSIONPROOF MATERIAL AND CONSTRUCTION

4836 RIDGE ROAD CLEVELAND, OHIO

PRO & CON . . .

equal. If we include the interest on the initial investment the inequality shows up.

The first plan actually represents a yearly cost of (0.04) (15,000) or $600 for interest on the initial investment plan $7,353 to perpetuate the system *after* the initial cost. The total yearly cost is thus $7,953.

The second plan actually represents a yearly cost of (0.04) (58,074) or $2,323 for interest on the initial investment plus $7,353 or $9,676 total yearly cost.

My calculation in the article gave $47,740 as the maximum for the special anodes. A yearly end-of-year payment of $6,043 will amount to $47,740 at the end of 7 years. To this $6,043 must be added (0.04) (47,740) or $1,910 for the yearly interest on the initial investment. The total yearly cost is thus $7,953.

Note that this yearly cost of $7,953 is exactly equal to the yearly cost for the regular anodes when interest on the initial investment is included in that calculation, as shown above.

Mr. Rubin has recalculated two other examples of te article but makes the same error. The calculations as given in the article were correct.

During the preparation of the article some of the examples were checked against the sinking fund method and exact agreement was obtained. The sinking fund method is fundamentally correct and Rubin obtained wrong results because he overlooked one factor. The capitalized cost method is more direct and avoids errors which are so easily made in this type of calculation.

F. C. Jelen

Solvay Process Div.
Allied Chemical & Dye Corp.
Syracuse, N. Y.

Pro: Depreciation Charges

Sir:

As I understand Mr. Rubin's comment, it concerns the "controversy" of depreciation on a present-worth basis versus a straight-line basis. I will give my views without

expecting that he will agree with them.

The depreciation reserve accumulated in anticipation of eventual retirement of property, when invested in securities, will earn the income derived from such securities; when invested in plant, it will derive the applicable return earned on that investment. To this extent, the present-worth principle is correct in theory.

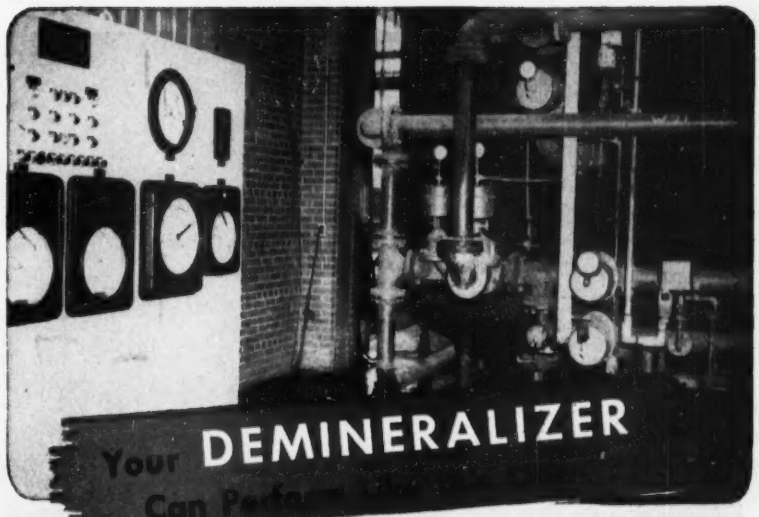
A regulated public utility company with relatively long-lived property and a relatively stable rate of return has substantial justification to recognize the present-worth factor. In its work with public utility companies, Ebasco Services has advocated present-worth depreciation in many cases, but the state public utility regulatory commissions have been reluctant to accept it and the federal commissions, FPC and SEC, have generally rejected it.

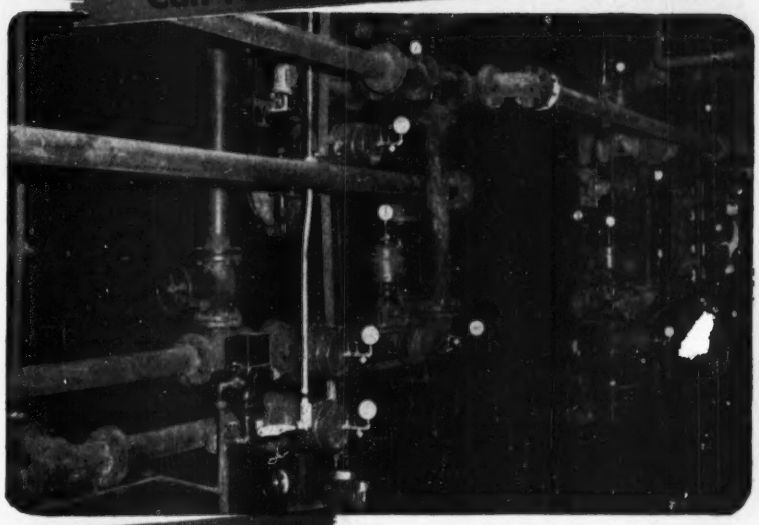
Unregulated industry, in general, has rejected present-worth depreciation for the straight-line or zero interest method. Considering the proposed revision of the Internal Revenue Code to liberalize provisions for use of declining-balance depreciation for tax purposes, there is a possibility that the future trend may be in the opposite direction. Very few organizations, particularly those of small or medium size, wish to keep different sets of depreciation records for tax and accounting purposes.

In addition to objections to present-worth depreciation because of complexity (the common objection) and tax considerations, there is a sound reason why the pure theoretical aspects of the present-worth principle are impracticable for unregulated industry.

If the theory is applied with consistency, the present-worth discount rate should be the rate of return from the investment of depreciation funds over the life of the property. During prosperous times, the return in many industries may be 15-20 percent; during periods of depression, it may be negative.

Moreover, often a pay-off period for the recovery of investment of from 1-5 years is demanded and





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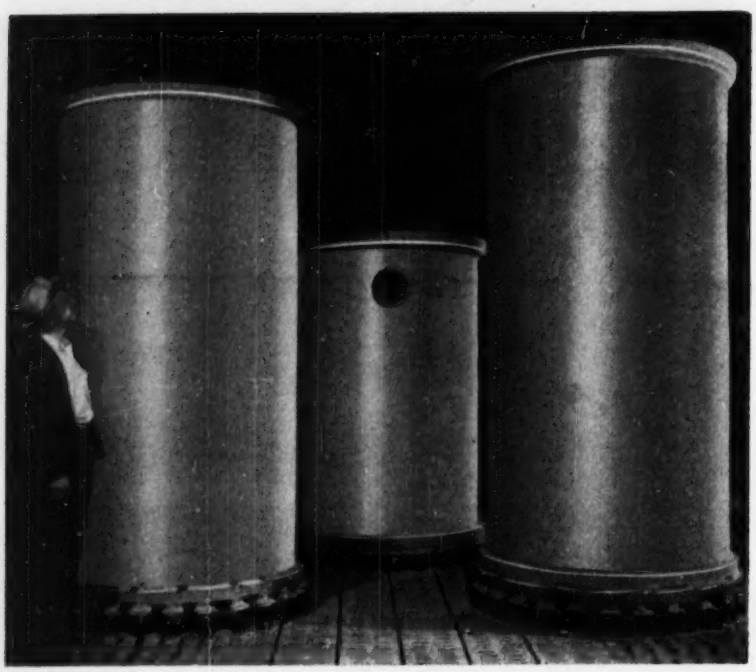


KNIGHT-WARE gives positive Corrosion Protection

The two large Knight-Ware vessels pictured above are parts of bromine cells used in the recovery of bromine from brine. Knight-Ware excels in this highly corrosive service because it is acid-proof throughout its entire body and is made in one seamless, jointless piece. The smaller vessel is a large sump which was made to specification for neutralizing waste acids from a laboratory.

Knight-Ware Chemical Stoneware is acid proof throughout its entire body.* It requires no linings or coatings for corrosion protection. No expensive molds or forms are required—hence special pieces may be made at relatively low cost. Different sizes and locations of connections and other changes from catalogued dimensions are possible in most units.

Knight-Ware is available in a wide range of types and sizes of chemical equipment. These include pipe, ductwork, tanks, kettles, jars, filters, towers, plug cocks and many others. Knight engineers are glad to cooperate in designing special equipment to specifications.

WRITE FOR BULLETIN NO. 12B, KNIGHTWARE

* excepting hydrofluoric acid and hot caustics

KNIGHT-WARE

Maurice A. Knight 106 Kelly Ave., Akron 6, Ohio
Acid and Alkali-proof Chemical Equipment

PRO & CON . . .

realized. In such cases, the rate of return may approach 100 percent.

Looking into the future, the rate of return to be expected may be substantially different for property with an estimated service life of 40 years. If, in later years, with a low present-worth reserve, the company fails to earn the expected return on its investment, it will be unable to endure the increasing depreciation charges which would be necessary.

The deferment of depreciation resulting from the present-worth principle also discourages replacement with newer, more efficient equipment, unless improved equipment can be anticipated in the estimated service life. Advocates of the declining-balance method of accruing depreciation point to the reduction of risk in their method, however illogical it may be from the standpoint of cost calculation.

Where imputed interest or return on investment is to be considered (such as in calculation of engineering economy) consistency demands that the present-worth principle be considered with depreciation cost.

But in cost accounting and for tax purposes, where imputed interest or return usually is not considered as a cost, it seems inconsistent to recognize the present-worth principle in connection with depreciation. To do so would increase costs of production with the increasing age of the property in addition to those increases which already arise from its declining efficiency and its accumulating maintenance requirements. Where cost is a base for establishing prices —which it often is despite economic theory—the use of new equipment would result in abnormally low price quotations or else in nominally exorbitant profits.

Still another point. In the average plant, depreciation does not represent a very large part of total manufacturing cost. Many businessmen say that the cost of incorporating this refinement in their accounting exceeds the cost of their depreciation. Not understanding the practical methods which have been developed for simplifying the application of present-worth princi-

ple, they may be mistaken. Unfortunately they are hard to convince.

ALWYN M. HARTOGENSIS
Systems & Methods Dept.
Ebasco Services, Inc.
New York, N. Y.

We welcome short, pertinent letters from our readers giving their opinions on developments in the chemical engineering profession and in the chemical process industries. Address the Editor, Chemical Engineering, 330 West 42nd Street, New York 36, N. Y.

—LITTLE BONER—

Mistaken Identity

The pilot plant group—mostly hard-working young chemical engineers—had sweated it out for three days and nights on a super-rush order for three drums of specially-fractionated fatty alcohols. Seventy-two hours of sweaty, stinky work—all for the sake of three drums!

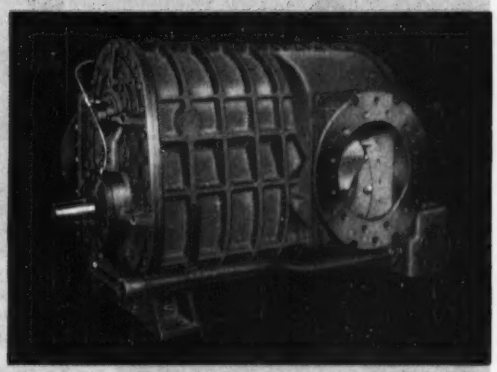
Finally, at about 2:00 o'clock in the morning, it was all over. The project leader, dead tired, took a piece of chalk and scrawled "DuPont" on the top of each drum. Then he left word at the office that they were to be shipped out very first thing in the morning. Everybody went home happy.

But next morning the drums couldn't be found anywhere. After searching high and low, somebody called up the night cleanup man.

"Oh sure," he answered cheerfully, "there was three drums and some guy had wrote 'dump out' on them and so I done it!"

"Somehow," the project leader wrote us, "the people down at DuPont never seemed to appreciate our explanation."

If you have a true "little boner," why not send it to the Editor, Chemical Engineering, 330 West 42nd St., New York 36, N. Y. We don't reveal identities.



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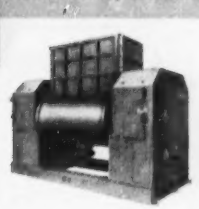

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WHAT'S HAPPENING . . .
(Continued from page 138)

Celanese Studying New Fertilizer Plant

Convinced that the trend in fertilizers is toward higher analysis types, Celanese Corp. of America is investigating sites and checking potential markets for a big new fertilizer plant. "Looks attractive," is all company officials are saying right now.

If built, the plant will probably cost over $10 million. Capacity, probably of nitrophosphate fertilizer, will be 150,000 to 200,000 tons a year.

Oil-From-Coal May Foster Rubber Plant

The first commercial production of gasoline and other "petroleum" products from coal will start this summer in the Union of South Africa. Being built by M. W. Kellogg for the South African Coal, Oil, and Gas Corp. (Sasol), the plant may well be a precursor to a synthetic rubber industry in that country.

Sasol's operation is expected to produce 55 million gal. of gasoline, 4.5 million gal. of diesel oil and over one million gal. of fuel oil annually. In addition, important byproducts, such as benzene and ethyl alcohol, will be made. And that's where the possible rubber industry fits in.

South Africa is currently importing about 29,000 long tons of rubber a year. But the bulk of this could be synthetic and would justify a synthesis plant making 20,000 tons annually. Raw materials needed would be one million gal. of benzene and either 14 million gal. of ethyl alcohol or 74,000 long tons of calcium carbide.

Natal sugar fermentation plants and Sasol could provide 7 million gal. of ethyl alcohol and Sasol alone could supply the benzene. Calcium carbide is also made in South Africa and production could be expanded if this route were chosen.

N. J. Zinc Buys TiO_2 Pigments Plant

After several years of research and development work, The New Jersey Zinc Co. has decided to get into the titanium pigments field. To facilitate this, the company recently contracted to purchase American Cyanamid's 20,000 ton-per-yr. titanium dioxide plant at Gloucester City, N. J.

Actual transfer will probably not take place until late in 1955, by which time Cyanamid expects to start operating a new and bigger titanium pigments plant in Savannah, Ga. Even so, this is sooner than a new plant could be built and put in operation. And New Jersey Zinc gets the added advantage of a plant that's already manned by trained personnel.

Zinc's final decision to go ahead came when raw material in the form of titanium-rich slag—70 percent TiO_2—was made available by Quebec Iron and Titanium Corp. This Canadian firm, owned jointly by New Jersey Zinc and Kennecott Copper Corp., produces iron and slag from ilmenite deposits in the Lake Allard region of Quebec.

Oil Reforming Capacity Continues to Build

Expansion news in the petroleum industry this month continues to center on catalytic reforming units. Cat cracking, fluid coking and alkylation projects were also active. Here's a rundown:

- Work has started at The Texas Co.'s Eagle Point Works, Westville, N. J., on a platformer and an alkylation unit, 12,000 and 1,926 barrels per day, respectively. Procon, Inc., Des Plaines, Ill., is the contractor.
- Sinclair Refining Co. will build a 16,000 bpd. catalytic reformer at East Chicago, Ind. A new platinum catalyst will be used. Also, steam will be supplied by a new type boiler that converts waste carbon monoxide from the reformer kiln into usable heat. (See *Chem. Eng.*, April 1954, p. 114.)
- Over $15 million is scheduled by Esso Standard Oil Co. (N. J.)

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Perhaps you require an exchanger for elevated pressures like this 3,355 sq. ft. unit, designed for a tube side pressure of 900 p.s.i.g. We are regularly manufacturing shell and tube units for pressures up to 3,000 p.s.i.g. and shell and coil units for pressures in excess of 5,000 p.s.i.g.

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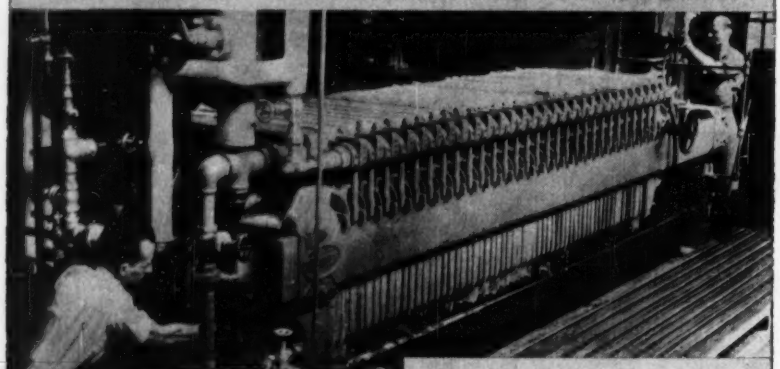

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• A contract for engineering and construction of a new Houdriflow cat cracker at Toledo, Ohio, has been awarded by the Sun Oil Co. to Catalytic Construction Co. It will process 27,000 bpd. of crude oil and is expected to be completed early next year.

Stanolind Acquires Carthage Hydrocol

At long last, it's official. Stanolind Oil & Gas Co., a subsidiary of Standard Oil Co. (Ind.), has exercised its option to take over the stock of the gas synthesis plant of Carthage Hydrocol, Inc., at Brownsville, Tex. In doing so, Stanolind guarantees repayment of the Reconstruction Finance Corp. loan to Carthage, amounting to over $17.5 million.

Built at a cost of over $50 million by nine companies, the Carthage plant was designed to make 7,000 barrels of synthetic liquid fuels and 300,000 lb. of oxygenated chemicals per day from natural gas It has never operated at more than one-third its capacity, however, and was shut down completely in June 1953. This was quite a blow to Stanolind which had built a $14 million plant to separate and purify alcohols, aldehydes, ketones and acids from the Carthage chemical stream.

Decision to take over the plant came after four months of evaluation by Stanolind, with assists from Lummus Co. and Hydrocarbon Research, Inc. The process has been adjudged sound in principle, based on Stanolind's extensive pilot plant studies, but many months will elapse before production begins. Considerable redesign, including in-

stallation of a second synthesis-gas generator, is necessary. And instead of the one nine-ft. reactor now used, a number of 3-ft. ones will probably be built.

Lummus Co., New York, has been selected as contractor for this revamping. Project engineering work has already begun and construction should start in August.

Stanolind has also completed arrangements to acquire the Brownsville storage terminal of U. S. Industrial Chemicals Co., a plant that adjoins both the Carthage and Stanolind plants. The three will operate as a unit.

Former owners of Carthage were The Texas Co., The Chicago Corp., Forest Oil Corp., Hydrocarbon Research, Inc., La Gloria Corp., Niagara Share Corp., Stone & Webster, Inc., United Gas Corp. and Western Natural Gas Co. Several of these had already completely written off their investments.

Magnesium Will be Made From Waste Cell Sludge

Construction of a plant for recovering 2.5 million lb. a year of magnesium metal from electrolytic cell sludge has been started by Dow Chemical Co. at Freeport, Tex. Operations will probably begin in July.

Cell sludge is solid waste formed during electrolytic production of magnesium, mostly magnesium oxide wetted with molten salts. Being heavier than the molten cell bath, the mixture sinks to the bottom of the pot, carrying small amounts of magnesium with it.

Dow's recovery process consists of crushing the solidified sludge, then ball milling to extreme fineness. Magnesium metal particles are somewhat larger than those of the salts, so simple screening achieves the final separation.

Oil Spray Helps Control Pollution

Airborne industrial wastes are being minimized at Disco Co.'s Pittsburgh, Pa., coke pellet plant by use of an oil spray. Four months of test operations show that the

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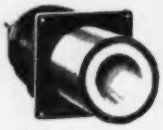

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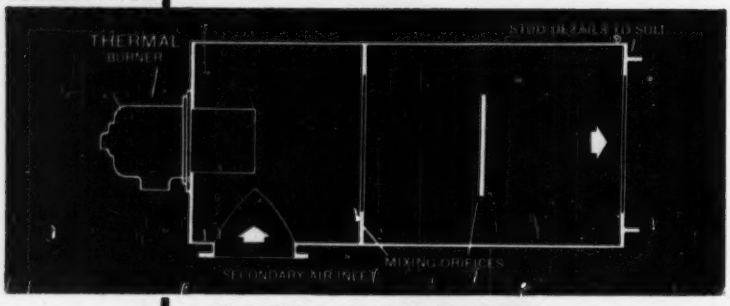
FOR DETAILED INFORMATION WRITE FOR BULLETIN 104



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spray, which was developed in conjunction with Gulf Oil Co., has nearly perfected pollution control and gives a new high in cleanliness for an operation of this type.

Disco, a division of Pittsburgh Consolidation Coal Co., mixes fines recovered from screening of its finished products with crushed coal. This mixture is heated in roasters and kilns for low temperature carbonization, then reduced to maximum 6-in. diameters by crushing.

Mechanical measures to prevent dust emission are not wholly successful, so the company decided to try a very fine oil spray to increase the effectiveness of its equipment. When oil hit the mixing point of fines and crushed coal, only a white vapor was given off. When the sprayed material was fed to the roasters, the only resultant discharges from the stacks were thin white plumes.

The oil apparently functions by coating the powdered fines and coal so all dust is held on the surface and subsequently carbonized. Some product is saved in this manner, reducing treatment costs. In addition, there is less exposure of bearings, conveyors and belts to dust abrasion.

AEC Plans Six New Atomic Power Reactors

Peaceful uses of atomic energy should get a big boost in the next five years when the six new power reactor projects proposed by the Atomic Energy Commission are completed. Five different technologies will be explored.

Farthest along is the pressurized water reactor in which private industry was invited to share. A full-scale atomic plant to produce electric power will be built and operated by Duquesne Light and Power Co., Pittsburgh. Total cost will be $45 million and a minimum of 60,000 kw. of salable electricity will be produced when the plant goes on stream sometime in 1957. Duquesne's part in the project is expected to relieve the taxpayers of $30 million in expenditures.

The second project is to be a

breeder reactor scaled up from 170 to 15,000 kw. of electric power. Auxiliaries, such as pumps, heat exchangers and valves, will be big enough for a full-scale reactor.

An experimental boiling water reactor with 5,000 kw. of electricity output will be an attempt to develop an economical way of getting heat out of the reactor by using the boiling reactor water directly.

Two homogeneous reactors are planned. One will be a slight scale-up of the small prototype at Oak Ridge. The other will produce 65,000 kw. of heat and breed uranium 233 in a blanket of thorium surrounding the core.

The sixth involves sodium graphite technology. Designed to make 20,000 kw. of heat, but no electricity, it will combine sodium as a coolant and graphite as a moderator, giving high temperature without high pressure. The entire project is expected to cost $10 million and North American Aviation Co. will assume $2.5 million of this.

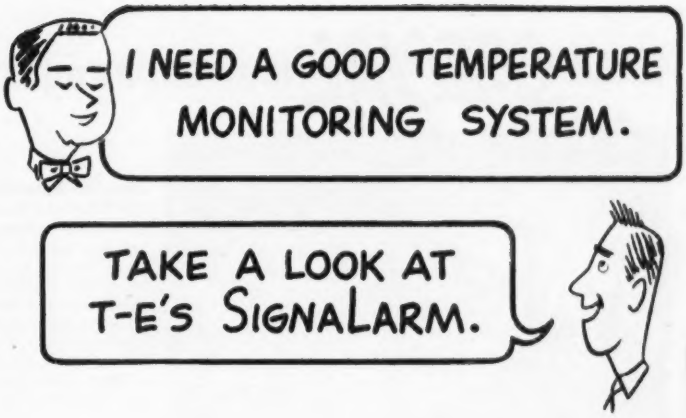
More Ammonia Plants For Hercules Powder

A pair of ammonia plants, one to be built, the other leased with an option to buy, have increased substantially Hercules Powder Co.'s stake in agricultural chemicals, fertilizers and insecticides. A total of 87,000 tons a year of ammonia is involved.

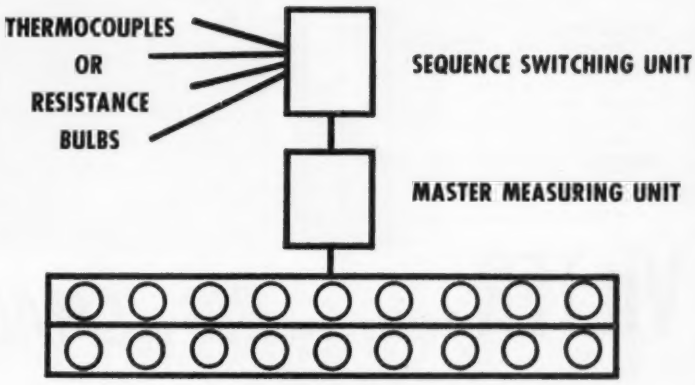
First came an agreement with the Alabama By-Products Corp. to build a 45,000 ton/year anhydrous ammonia plant in Birmingham, Ala. Construction is expected to start almost immediately, with completion scheduled for 1955.

Next, Hercules signed a lease with an option to buy the Government-owned Missouri Ordnance Works for $3,625,000. This consists of three high pressure anhydrous ammonia lines using natural gas as a raw material. Capacity is about 42,000 tons annually.

Although this plant has been in stand-by condition since late in 1945, Hercules expects to have it partially on stream by July or Au-



Thermo Electric's SignaLarm is a temperature monitoring system composed of well-tested, standardized units. Each SignaLarm system consists of 4 basic parts:



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Different temperature monitoring systems can be built-up from standard SignaLarm units. Each SignaLarm can handle up to several hundred thermocouples (or resistance bulbs). Additional systems can be installed for greater capacity, or for high-speed scanning, or for monitoring various temperature points independently of one another.

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Ammonia Synthesis and Recovery Cooler
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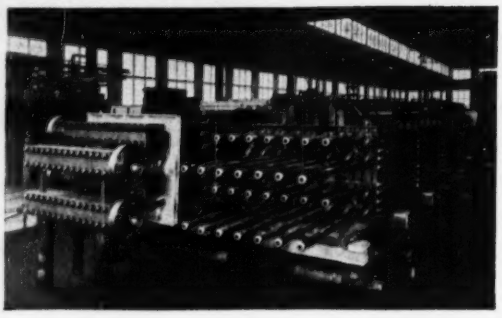
Ammonia Synthesis and Recovery Liquefier Coil Assembly
Nearing completion in the Vilter shops, these units use 6600 feet of 2" double extra heavy seamless pipe, weighing 20 tons without headers or external shell. All Vilter-built, it will work at 3500 pounds pressure and will be installed within pressure shells.



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gust. Capacity production is expected in September 1954. Built by Hercules for the Army in 1941-2, the Missouri Ordnance Works originally had five ammonia lines. Two of these were later dismantled and set up at San Jacinto, Tex.

Mallinckrodt Offers More Common Stock

Early last month, Mallinckrodt Chemical Works filed a registration certificate with the Securities and Exchange Commission covering 75,000 shares of its Class A, non-voting common stock. This marks the company's first public offering of stock since its founding in 1868. The proceeds will be used chiefly at the firm's St. Louis, Mo., plant.

Primarily a producer of fine chemicals, Mallinckrodt has authorization for 360,000 shares of Class A common, of which 180,000 are now outstanding. In addition, the company has issued 120,000 shares of Class B common, out of a total of 240,000 shares authorized.

Government Authorizes More Ammonia Capacity

Despite industry protests, partially butressed by a Business and Defense Administration survey of existing capacity, the Office of Defense Mobilization has decided to sponsor an extra 163,000 tons of annual ammonia capacity under its recently increased nitrogen expansion goal (see *Chem. Eng.*, May 1954, p. 378).

Most of this, however, will go to plants already being built. About 20 applicants, representing 600-700 thousand tons of contained nitrogen, are contesting for certificates of necessity under the new goal. Roughly a third of these are new, the balance having been turned down before the authorized increase.

The controversy began when ODM boosted its nitrogen target from 2.93 million tons by Jan. 1955 to 3.5 million tons by Jan. 1957. Many industry sources felt this was too high, therefore set up

a capacity survey under sponsorship of BDSA. This showed existing capacity, including that under construction, of 2,881,700 tons of nitrogen in the form of ammonia. In addition, an estimated supply from byproduct and organic wastes of 265,000 tons was reported, making a total of 3,146,700 tons.

ODM accepted these figures and tacked on outstanding certificates for 190,300 tons on which construction of facilities has not yet started. This left a balance of 163,000 tons.

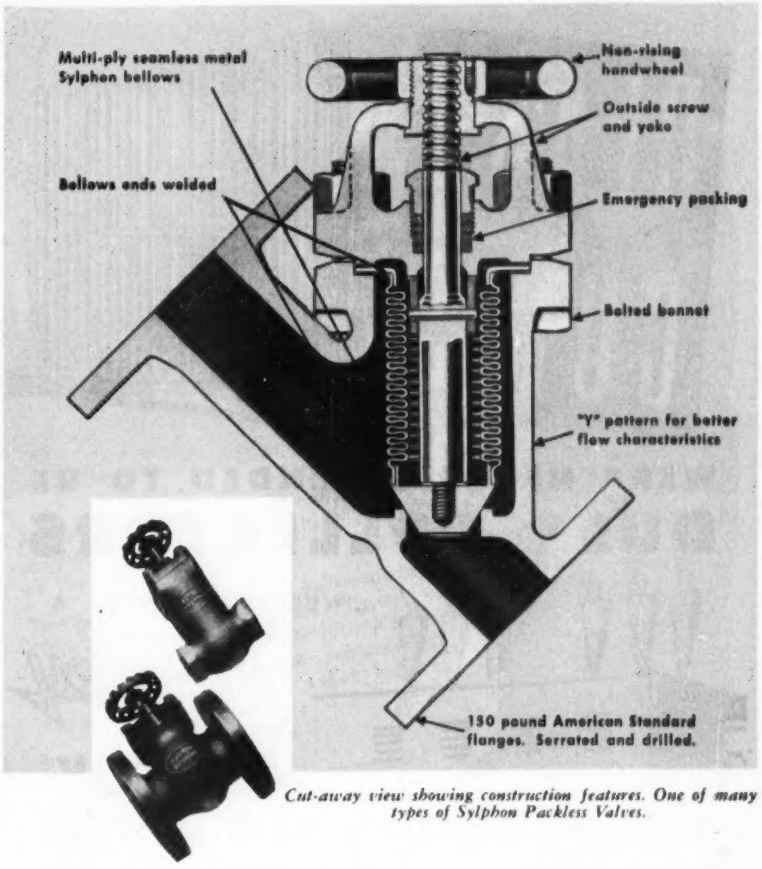
What ODM did not accept for purposes of setting an expansion goal were survey contentions that in an emergency, existing ammonia plants, by disregarding efficiencies and costs and by undertaking minor construction to eliminate bottlenecks, could produce about 15 percent in excess of rated capacity. This would give a potential supply of nearly 3.8 million tons of nitrogen in 1957, not including any new plants authorized under the new goal.

Plans Progress for Big Oil-Chemical Union

The Oil Workers International Union (CIO) will meet in special convention about June 1 to ratify the proposed constitution of the new Oil and Chemical Workers International Union (See *Chem. Eng.*, May 1954, p. 112). Approval by OWIU, the largest union in the petroleum industry, is expected to come quickly.

To increase the likelihood of constitutional ratification by the many independent oil unions, the new organization has issued two pamphlets explaining its objectives. The first, "What Can an International Union Do for Me?", states that company-wide councils will be established "to coordinate and unite the efforts of all members employed by the same company."

Also, "the international will coordinate and unite the efforts of all the members in all the locals. This means that when your local goes before management to ask for improvements in wages or conditions, it will not be standing alone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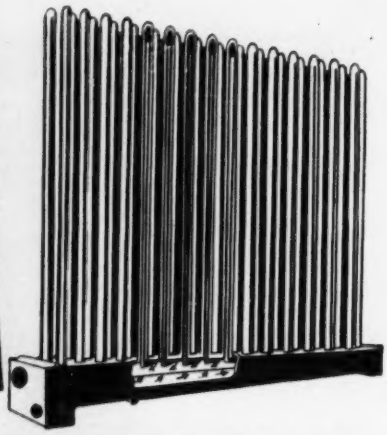
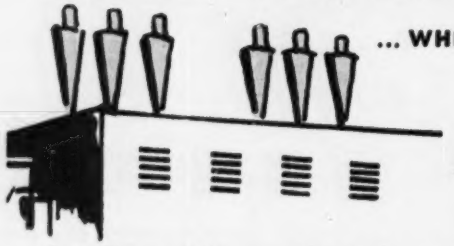


WERE NEVER INTENDED TO BE

DUST COLLECTORS



... WHEN YOU INSTALL A

Bayley CHINOOK®

It Functions Solely As A HEATER

Unless a Blast Coil is selected of correct design for the service conditions, it may operate more like a dust collector than the industrial heater for which it is intended . . .

In contrast to conventional fin-type heaters, a "CHINOOK" Blast Coil — designed exclusively by BAYLEY — always *stays clean!*

NO CLOGGING — Impossible in a "CHINOOK" Heater, because there are no fins between which dust, lint, fibres, etc. can collect.

NO FREEZING — Safe when subfreezing air is passing over surface.

NO TEMPERATURE STRAINS — Single-header construction permits continuous, innumerable cycles of expansion and contraction without damage.

NO SHORT-CIRCUITING — Free and positive circulation of steam, air, and water always in one direction, insures effective prime heating surface from every square foot of the coil.

Bayley BLOWER COMPANY
1823 S. 66th Street
Milwaukee 14, Wisconsin

Get the Complete "CHINOOK" Heater Story — In This New 24-Page BAYLEY Catalog. Mail Coupon TODAY for Bulletin CH-532.

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Send us a copy of Bulletin CH-532, Covering Bayley "Chinook" Blast Coils.

Name..... Title.....

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.....

against a huge, world-wide, billion dollar corporation and against a tightly united and interlocking oil industry. Instead, your local will be able to coordinate its efforts with many other locals so that the combined pressure of all may be brought against your company and the industry."

The second pamphlet is called "Who Will Run My Union?" It states that "most of the control will be exercised in your local union halls . . . The international's main function will be to assist, rather than control, and to coordinate the efforts of the locals."

However, "the constitution provides for the establishment of an international bargaining policy committee, the majority of members of which will be rank and file workers. . . This committee will have the authority to establish 'mandatory' policies covering some of the bargaining items. If and when the committee does so, each bargaining group is prohibited from signing a contract not measuring up to those policies unless the committee grants an exemption to the group."

New Technique Yields Alkylated Compounds

Using a new alkylating agent—n-octadecyl p-toluenesulfonate—researchers at Tulane University have come up with a new process for altering molecular structures. The resulting products are expected to find use in lubricants, additives, plasticizers, insecticides, therapeutic agents and surface active agents.

The process entails the actual introduction of the agent into such varied organic types as phenols, mercaptans, alcohols, amines, salts and benzene. Here's a partial rundown on the materials treated:

- Phenols and mercaptans—p-nitrothiophenol, o- and p-thiocresol, n-butyl, decyl, dodecyl and octadecyl mercaptans and 1, 2-ethanedithiol.
- Alcohols—ethylene glycol (to form n-octadecyl and di-n-octadecyl ethers), 2-octanol, 1-butanol, 1-octanol, 1-octadecanol, benzyl alcohol

and beta-hydroxyethyl mercaptan.

• Amines-aniline, m-chloroaniline, n-butylamine, p-toludine, beta-napthylamine and diphenylamine.

Work was headed up by David A. Shirley of Tulane. Sponsorship was by the U. S. Dept. of Agriculture's Southern Utilization Research Branch. USDA's interest stems from the fact that the alkylating agent can be derived from commercial vegetable oils.

Copies of reports on the technique used are available from both Tulane and USDA.

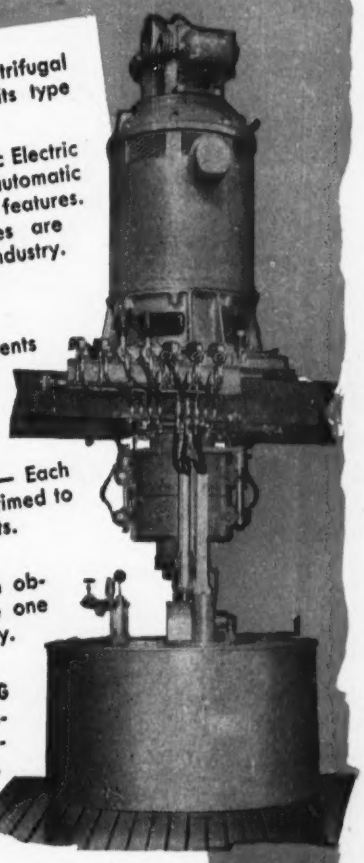
News Briefs

Titanium: Du Pont has cut the price of ductile titanium metal sponge. The new prices are $4.72 per lb. for Grade A-1, which contains 0.3 percent iron, max., and $4.46 for Grade A-2, containing 0.5 percent iron, max. The old price was $5 per lb. for both grades. The company credits an improved process and expanded facilities for the reduction. Titanium research is currently costing Du Pont about $1 million a year.

Fertilizer: The largest nitrogen fertilizer plant in Poland is now in partial operation near Kendzezhin on the Odra River. When full production is reached in 1955, the unit is scheduled to produce one million metric tons a year of nitrogen fertilizers, twice the total Polish output in 1952.

Fluorothene resins: Carbide and Carbon Chemicals Co. is now turning out commercial quantities of fluorothene resins from its continuous plant at S. Charleston, W. Va. Sales are being handled by the Bakelite Co. A specialty type plastic, fluorothene is claimed to be the only easily proocessed material known that exhibits excellent toughness, heat resistance and volume resistivity at both room and elevated temperatures.

automatic
HIGH PRODUCTION
CENTRIFUGALS



A continuous recycling automatic centrifugal unrivaled by any other machine of its type on the market today!

That's the new Roberts G-8 Automatic Electric Drive Centrifugal. It combines fully automatic operation with extra high production features. Many of these producton features are exclusive "firsts" for the entire industry.

COMPLETELY AUTOMATIC—All components of the duty cycle are interlocked, assuring accurate timing of successive operations.

ADJUSTABLE, TIMED DUTY CYCLE — Each component of the cycle can be timed to suit your production requirements.

MACHINE OPERATOR—Acts as an observer only; is free to operate one machine or a complete battery.

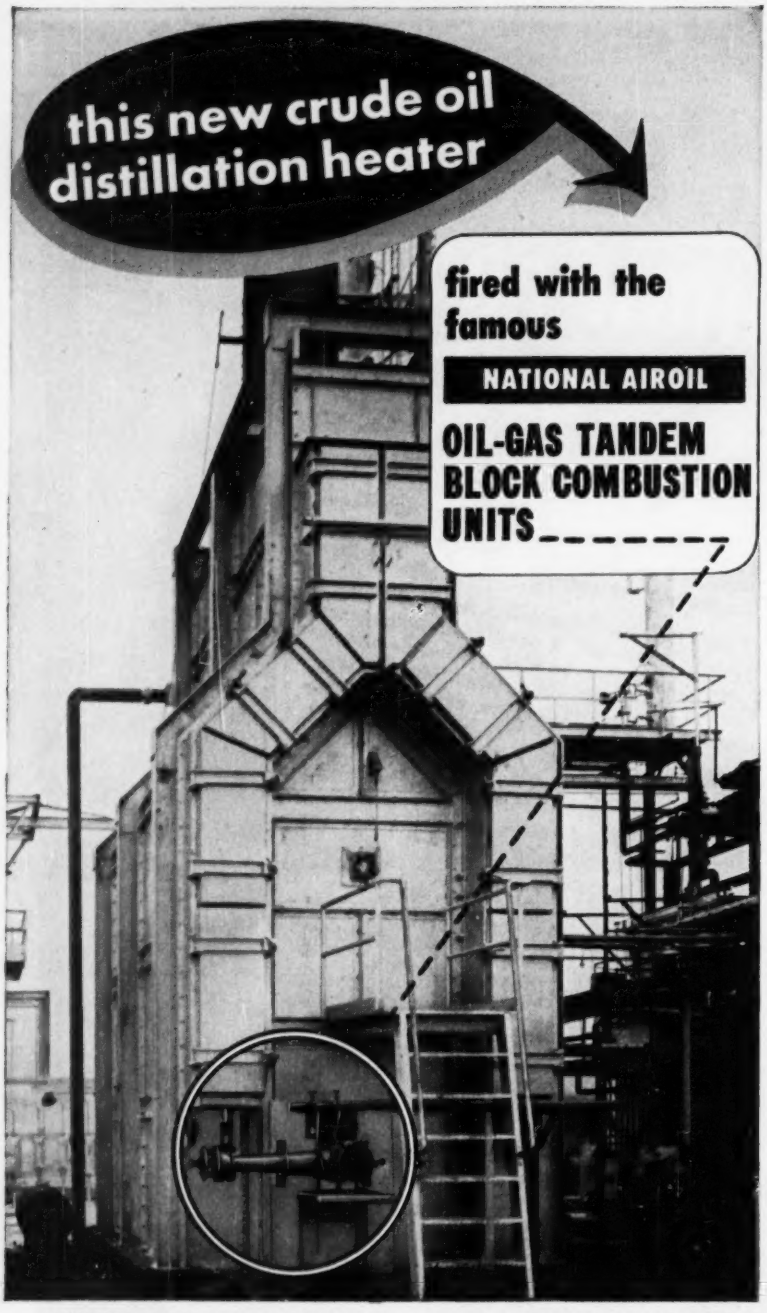
ADJUSTABLE AUTOMATIC LOADING—Loading gate closes automatically when basket has received predetermined charge.

RECYCLING—Automatic recycling assures constant production.

LARGE BASKET—48" x 30" basket enables the G-8 to handle larger loads.

These are just a few of the reasons why the new Roberts G-8 Automatic Electric Drive Centrifugal is the machine for your operations. For further FREE information on the G-8 and other types of Roberts Centrifugals, write to The Western States Machine Company, Hamilton, Ohio.

ROBERTS STEVENS
The WESTERN STATES MACHINE COMPANY
HAMILTON, OHIO, U. S. A.



. . . MEANS MANY MORE HOURS ON STREAM WITHOUT SHUTDOWN

This heater (RJ Oil & Refining Co., Inc., Princeton, Indiana) is fired from each end with one of NATIONAL AIROIL's #2 combination oil and gas, patented, Tandem Block Combustion Units.

The Tandem Unit is always fired with NATIONAL AIROIL Combination Oil and Gas Burners . . . has a high turndown ratio with a steady flame . . . maintains required temperature using either fuel . . . radiates heat uniformly without tube impingement. With the Tandem Unit's clean flame, a cold furnace can be brought to full capacity in a shorter time.

You will realize more satisfaction from YOUR heaters when NATIONAL AIROIL Tandem Combustion Units are specified.

NATIONAL AIROIL BURNER CO., INC.

CHEMICAL-PETROLEUM DIVISION
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Southwestern Division: 2512 South Boulevard, Huston 6, Texas

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

THIS MONTH'S

Technical

Parade

CHEMICAL PROCESS MACHINERY. 2nd edition. By E. R. Riegel. Reinhold Publishing Corp., New York. 735 pages. $12.50.

Reviewed by Julian C. Smith

The second edition of this exhaustive treatise on chemical processing equipment closely follows the pattern of the 1944 edition. Machinery for various operations is described in detail, with numerous photographs and some numerical examples. Sizes, fields of application, and approximate costs are included. The principle of operation of the machines is clearly explained, usually without detailed reference to the underlying theory. The book is primarily descriptive of commercially available equipment and its applications in industrial processing.

In the new edition some obsolete material has been eliminated and much new information has been added. Multispheres, high-speed continuous centrifuges, venturi gas scrubbers, and continuous classifying crystallizers are examples of equipment described for the first time. The length of the book has increased by 152 pages. As before, several chapters were written in collaboration with various specialists, to give a very thorough coverage of processing equipment.

The author likens the book to a series of show windows, displaying commercially available machinery. The displays are well arranged and attractive: the quality of the paper, the type size, and the layout are all good. The book is too complete for a student text, however; the endless parade of equipment types is disheartening to the inexperienced. Discussions of operating principles are overshadowed by descriptive matter of secondary interest in a college course.

For the practicing engineer, however, the book is a most valuable reference. With experience to guide him, the engineer can quickly learn

Bookshelf

L. B. Pope

what machines are on the market, and decide which types he should consider purchasing. There is no other source of so much practical information, in convenient form, on chemical processing machinery. The first edition was well received; the second, with its broader coverage, undoubtedly will be also.

Unintense

SILICONES AND THEIR USES. By Rob Roy McGregor. McGraw-Hill Book Co., Inc., New York. 302 pages. $6.

Reviewed by C. L. Mantell

This volume is an over-all picture of what silicones are and the ways in which they may be used. The volume is elementary in the explanation of the preparation of silicones from the raw material to the finished product, so as to make it understandable to the technical as well as the nontechnically trained person. Types of commercial products covered include silicone fluids, compounds, lubricants, resins, rubber and "bouncing putty," as well as the physiological response to silicones.

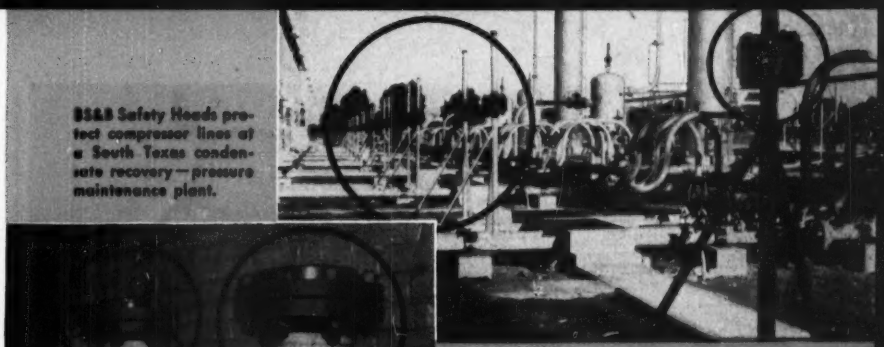
For those desiring to get a general background of the subject without being faced with the intense writing of the specialist, the book should be of value.

Fundamental Equations

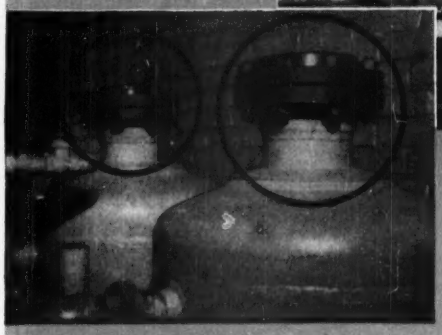
THE ATOMISATION OF LIQUID FUELS. By E. Griffen and A. Muraszew. John Wiley and Sons, New York, 1953. 246 pages. $6.

Reviewed by K. A. Kobe

In combustion processes using liquid fuels, the success of the combustion process is dependent largely on the degree of atomization of the liquid. Much empirical knowledge exists, but in this British book the important scientific papers have been used as a basis for a review of the fundamentals applicable to



BS&B Safety Heads protect compressor lines at a South Texas condensate recovery—pressure maintenance plant.



Equipment and personnel within a plant are protected from the hazards of overpressure in these vessels by BS&B Safety Heads.

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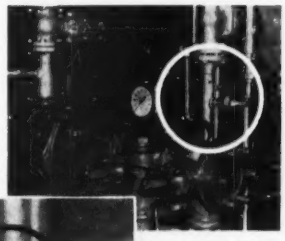
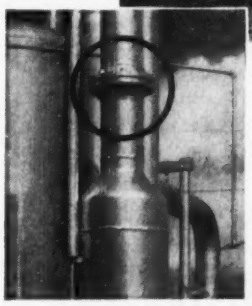
Have Hundreds of Applications!



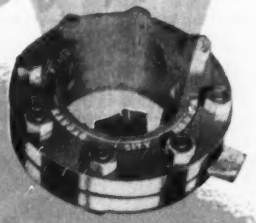


Here a BS&B Union Type Safety Head, with Monel rupture disc, is installed on a two-stage hydrogen compressor.

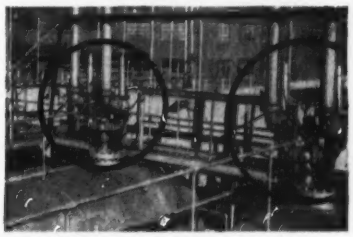
This BS&B Safety Head is mounted on the flare from a Pop Valve on an incoming gas line.

The variety of possible uses for BS&B Safety Heads is limited only by the number of different ways in which compressed air, gas or liquids—either bland or corrosive—are handled, processed or stored by our many manufacturing and processing industries! Wherever protection of a closed pressure system is required, there is a correct size and type of BS&B Safety Head to do the job! For detailed information, ask your BS&B Representative . . . or write to us direct.

BS&B Safety Heads



THE "CIRCUIT-BREAKER" OF
Any Pressured System



BS&B Combination Safety Head—Relief Valves protect 15,000 gallon butadiene storage tanks at an Akron, Ohio, rubber plant.

BLACK
SIVALLS &
BRYSON, INC.

Safety Head Division, Dept 2-N6
7500 East 12th St., Kansas City 26, Mo.

EFFICIENCY
OVER 60 YEARS
BS&B
RELIABILITY

THE $20,000 DRYER ORDER that PROCTOR & SCHWARTZ *Turned Down!*

It's not every day in the week that an order for a $20,000 piece of equipment drops into our laps. *And yet we turned down such an order*—because, if we had filled it, we would have violated this basic Proctor & Schwartz policy:

Every piece of P & S equipment must be a wise investment for the customer; must be capable of performing as he expects it and needs it to perform; must provide him with the quantity and quality of output that his operation requires.

In this case, the customer specified a particular type of drying equipment. Out of their long experience, Proctor engineers advised him to install an entirely different type. When the customer insisted that he would take only what he wanted, Proctor & Schwartz said: "Sorry, but we won't accept your order!"

Another manufacturer—reputable, but not nearly so long experienced as Proctor & Schwartz—gave the customer what he wanted. Within a week after the equipment was installed, the customer called us. "You were right", he said. "I've wasted $20,000 and lost a lot of valuable time. Let me have the dryer you recommended." We did—*and it's doing the job to the customer's complete satisfaction!*

There is no substitute for experience. And there is no one longer experienced—and more widely experienced—in the drying-equipment field than Proctor & Schwartz. When you have a drying problem, call Proctor engineers *first.* Meanwhile, write for Bulletin No. 390.

Proctor & Schwartz, Inc.
PHILADELPHIA 20, PA.
The World's First Name in Industrial Drying Equipment and Processing Machinery

TRAY DRYERS • TRUCK DRYERS
CONTINUOUS CONVEYOR SYSTEMS • PRE-FORMING FEEDS
INFRA-RED FREEZE-DRYING SYSTEMS • SPRAY DRYING

atomization. These fundamentals range from dimensional analysis to experimental assessment of fuel spray characteristics.

The mechanism of distintegration of liquid jets is presented first to give the reader the fundamentals of how droplets form and move in air. Following chapters discuss the way in which the spray characteristics are affected by the atomizer construction, the properties of the liquid, the properties of the gaseous medium into which the liquid is sprayed, the injection pressure, and intermittent and continuous sprays. The final chapter on experimental techniques gives methods of determining size of droplets, spray density, and spray velocities and angles.

Because atomization of liquids is of broader usage than for fuels alone, this book will be of value to the engineer interested in the spraying of liquids in fine sprays. The reader will find this book a welcome return from the usual numerous empirical formulas to fundamental equations.

Hardly a Treatise

TECHNOLOGY OF SYNTHETIC FIBERS. Edited by Samuel B. McFarland with a staff of 11 contributors. Fairchild Publications, Inc., New York, N. Y. 477 pages. $12.

Reviewed by D. F. Othmer.

As a background of comparison, the first 50 pages of this book are given over to the natural fibers—wool, cotton and silk. The most 20 pages are a discussion of by far the most important synthetic fibers, rayon and acetate, including a half page on cupra-ammonium. The next 25 pages are a discussion of the structure versus properties of fibers. Then comes 37 pages devoted to the condensation synthetics — Nylon, Dacron, Perlon, and 60 pages devoted to the vinyl synthetics — Orlon, Dynel, and Acrilan. Glass fibers come in for 13 pages to complete the 207 pages devoted to a classification by chemistry.

There is discussion of 27 pages

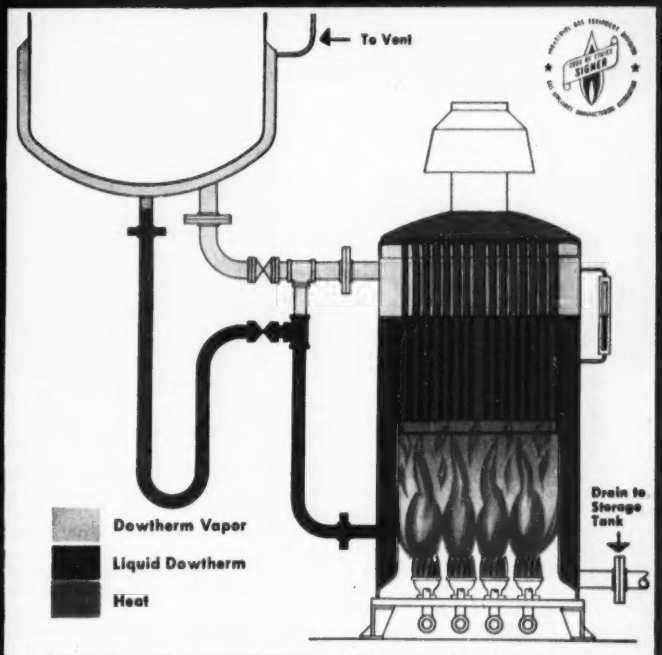
on the synthetic fibers of Europe and 17 pages on the synthetic fibers of Japan. The next 33 pages are given over to textile engineering or so-called "Fiber Properties versus End Use Requirements." Textile assistant including textile finishing agents receive 52 pages and properties of fabrics 35 pages. The 92 pages devoted to Chapter 13, Fibers of the Future, is largely a review of present fibers with various economic and technical data as well as some few guesses as to future fibers. Since this is largely concerned with current prices, cross-section photomicrographs, manufacturers of present fibers, etc., it is hardly crystal gazing.

This book may hardly be called a treatise but it is an interesting collection (not always too well organized) of much useful data on modern developments. Some 11 authorities, most of which are from industry in the several major companies working in this field, have given of their knowledge, although it is hardly to be expected that they would give their complete knowledge in their respective industrial capacities. There are hundreds of bibliographic references, a large number of items for selected reading listed after some of the chapters although not after most; and there is also a 14 page index which is cross-referenced. Most of the material seems to be useful and, in the usual case, authoritative.

The presentation, however, is far below the usual standards of technical book making. The book is prepared by photo-offset printing of typed pages with uniform left margins but varying right margins. Because of the method of reproduction there is a comparatively lesser amount of material per page than from set type. The lack of sufficient sizes and faces of the typing has also made for an unpleasant appearance of the book, with figure titles several times as large as section titles. Occasionally the reproduction of photographs and even drawing and lettering by the photo-offset process leaves something to be desired.

There is a great informality and an unevenness in the writing of the

Simple to operate, easy to control, no pumps or traps . . .



EFFICIENT FLOW OF DOWTHERM—with this simple gravity return system—provides rapid, consistent heat which is easily controlled for correct working temperatures. To start operation, needle valves are opened and air is evacuated. After all air is out, valves are closed and system remains under positive pressure . . . no further purging is necessary. Heat-user temperature is accurately controlled by regulating Dowtherm pressure in the Vaporizer . . . no control valve is needed in the vapor line. This remarkably efficient system is recommended for constant heat applications, such as distillation or polymerization. (Available in gas-fired, oil-fired or combination oil- and gas-fired.) System No. 1, shown above, is illustrated in detail in bulletin A-100. Send coupon below for your copy.

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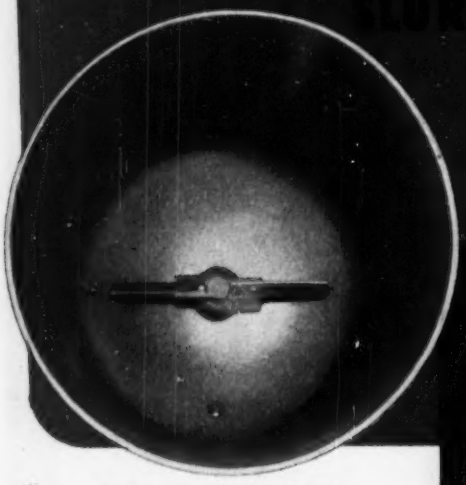
SPARKLER

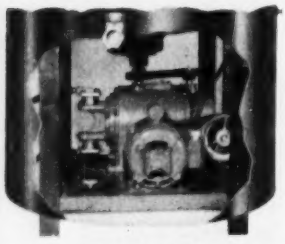
NEW TYPE COMBINATION UNIT

SLURRY FEEDER

For Diatomite and other Filter Aids



Interior of slurry tank showing agitator blades at bottom of tank.



Base exposed, showing motor, feeder.

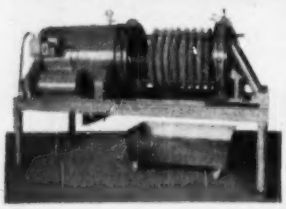
Completely enclosed feeder unit with tank cover.

The important feature of this new Sparkler combination unit slurry feeder is the slow speed agitator operating at the bottom of the tank, that has the advantage of not breaking down the natural cellular structure of diatomite thus preserving the full porosity of the diatomite cake. A much better high flow filter cake is built up with slurry from this feeder.

The top of the tank is fitted with a removable cover to keep slurry clean and sanitary. One motor enclosed with automatic feeder in the base of the unit operates both feeder and agitator.

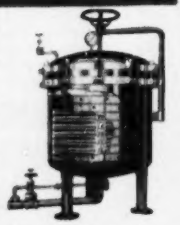
Tanks and agitator can be supplied in mild steel, stainless steel, or other metals to meet requirements.

All sizes and types of slurry tanks, surge and supply tanks, with or without feeders can be furnished in any metal as separate equipment.



Model M.C.R. vertical plate filter.

The well known standard horizontal plate model is particularly adapted for fine filtering. The vertical plate models SCJ and MCR are designed for heavy duty filtering and are available in sizes up to 2000 sq. ft. of filtering surface. The model SCJ is available for plant water supply up to 200,000 G.P.H. The retractable tank Model MCR for heavy residue material with semi-dry cake recovery.



Standard horizontal plate filter.

MUNDELEIN, ILL.

Canadian Factory — Galt, Ontario
European Factory — Amsterdam, Holland

BOOKS . . .

various chapters with personal pronouns abounding in many of the sections. Many of the tables are listed as figures and many of the figures are listed as tables. There is inexactitude about some presentations; e.g. on page 2 there are two curves—one is the population of the United States and the other is the number of pounds of textile fibers processed and both are plotted versus time. The title, however, is "Textile Fibers Processed in U. S. versus Population Growth."

By and large the book will surely find its place on the shelves of everybody interested in this particular field because of its collection of much useful information of high polymer chemistry, technology, economics, manufacturing techniques, characteristic properties, and dyeing properties of the various textile fibers. It gives much information which otherwise is widely scattered.

Inducements

ANNEXATION OF THE HEAVY INDUSTRIAL AREA OF CORPUS CHRISTI. By Stuart A MacCorkle. Issued by the Chamber of Commerce of Corpus Christi, Texas. 38 pages. $1.

The author has made an investigation of the industrial area, predominantly chemical and petroleum refining, surrounding the city of Corpus Christi, Texas, together with the factors to be considered prior to annexation. His principal conclusion was that annexation would impair the competitive position of the city in attracting new industry to the area and the continued growth and development of the city and surrounding area.

In the course of the report the author covers the types of inducements offered industry. As he states, attracting industry has become a highly competitive business. Many states offer some kind of tax exemption to manufacturing concerns. Louisiana appears to be the only state in which there is a state board that administers the granting of exemptions and the Board of Directors of the State De-

partment of Commerce and Industry with approval of the governor may contract with the owners of any plant proposing an addition for the exemption of the new plant or addition from state and local ad valorem taxes for ten years.

The Louisiana constitution was amended so as to permit the consolidation of the city and the parish of Baton Rouge. City services are furnished the rural and industrial zones of the parish on a contract basis by the urban zone or city. The industrial zone pays the city a certain percentage of the collected taxes of the area each year. It has the advantage of non-annexation by the city. The tax rate are lower than they would be if the area were taken into the city.

In 1936, Mississippi initiated what is known as the "Balance Agriculture With Industry" plan. BAWI, as it is called, allows communities in Mississippi to issue general obligation bonds to provide funds with which to construct buildings to lease to manufacturing plants. Since the plan was first adopted, three other Southern states have passed similar legislation.

Kansas has tried the industrial levy as a means of aiding industry. Legislation provides that all cities with a population of under 40,000 can levy up to one-half mill annually upon all property within the city for the purpose of securing manufacturing institutions for the city . By June of 1950 twenty-six cities had voted to utilize the legislation and eight had rejected it.

Philadelphia and Baltimore (since 1797) have provided for tax differentials to rural-urban fringe annexed areas. Virginia's annexation procedure also authorizes lower tax rates for these areas and tax differentials are possible under the Oregon law, provided classifications rest "on some reasonable basis."

A second method that has been used in a number of states to encourage industrial development is the industrial foundation. These have been responsible for a surprising number of plant locations in recent years. During 1953 legislation was passed in Massa-

Theorizing about weighing problems when you should be THAYER-IZING them?

SAVE TIME AND MONEY IN BAGGING, BATCHING AND CHECKWEIGHING WITH THAYER SCALES.

Why guess or gamble with improper scales. Use Thayer scales and enjoy outstanding accuracy, speed and convenience which assure quantity and quality control. Whether yours is a bagging, batching or checkweighing problem involving powder, pellets or dry mixes these important Thayer features can save you man-hours and increase your production:

- **Shockproof leverage system** — no wear-vulnerable knife-edge pivots.
- **Automatic control and operation** — you minimize "human factor" in weight determinations.
- **Optional design features** — capacities, controls, feeding systems, etc., easily designed to suit your needs.
- **Precision construction** — expert construction to proven design assures accuracy over long periods.

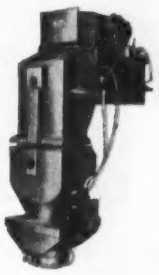
For more complete details on the Thayer Scale suited to your job, write outlining your problem.

Thayer Automatic Filling Scale Model 600G

For holding, filling and checkweighing bags of powdered materials to tolerances within 2 oz. Feeder handles both highly flooding materials and those which flood only at times. Utilizes both gravity flow (plus compressed air or vibration when needed) and positive "dribble" feed. When proper weight is reached, feed gates close and checkweight lights indicate end of filling cycle. If weight is O.K., light flashes and filled bag is dropped or held for push button release.

Handles up to 6 bags per minute of unit weights ranging from 25 to 200 pounds. Also available as a net-weigher. *Write for Bulletin 600G.*

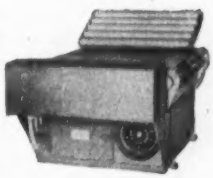
Thayer Fully-Automatic Filling Scale Model 400N



New fully-automatic scale for weighing and discharging loads for bagging or batchweighing. Dry materials in granular or pellet form are readily handled by unique feeding system that closely controls amount and rate of feed of any free-flowing material without pre-aerating or separating. Once speed and weighing controls are set, operation is completely automatic.

Handles weight units from 25 to 200 pounds at speeds up to 10 units per minute. Stainless steel feeding system. Also available as gross-weigher. *Write for Bulletin 400N.*

Thayer Checkweight Scale Model 200R

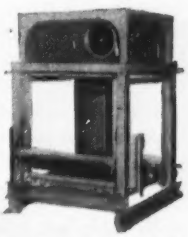


Automatically indicates weight of filled bags, drums and cartons. Offweight packages are separated from those properly filled by having the motor-driven, two-way conveyor deposit them at opposite ends of scale. Over- and under-weight tolerances are independently adjustable over a wide range.

Dial shows how much each package is offweight and horn sounds as each improperly filled package is discharged. Optional signal lights, remote dials, etc. available.

Model 200R handles up to 20 packages a minute with unit weights from 20 to 200 pounds. *Write for Bulletin 200R.*

Thayer Checkweight Scale Model 200S



This Thayer scale has same performance specifications as Model 200R but has the conveyor platform belt only 10" above the floor. With the conveyor located beneath the scale, the spillage from broken bags will fall to the floor and not affect the weight of the bags which follow.

Like the Model 200R, this scale may be equipped with additional dial indicators for installation at remote control stations, colored lights which show whether the package on the conveyor is over- or under-weight, or a printing recorder which records the exact weight of each package. *Write for Bulletin 200S.*

THAYER SCALE AND ENGINEERING CORPORATION
491 EAST WATER STREET, ROCKLAND, MASS.

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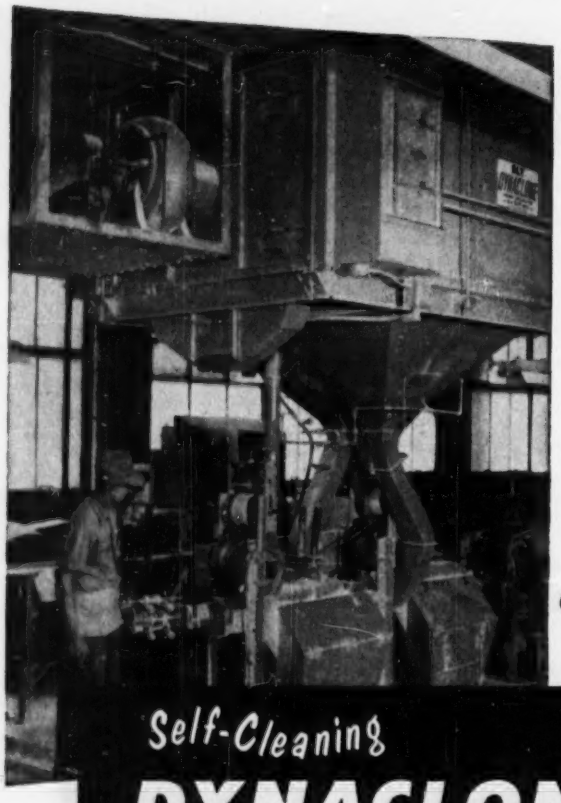
SLY PIONEERS & LEADERS in INDUSTRIAL DUST CONTROL



1 OF 4 UNITS AT GOODRICH

Self-Cleaning
DYNACLONE
The Ultimate Dust Collector

No matter how dusty your manufacturing operation, you can effectively control the dust. Take the case of The B. F. Goodrich Company.

This company processes garden hose by passing it through pigment dusting chambers. There are two dusting chambers—shown on the floor below the filter—one for soapstone (talc) and the other for zinc stearate.

Dust-laden air from this operation is drawn through vertical ducts to the Sly Dynaclone two-compartment Filter, above. The dusting compounds are kept separate and are returned to the chambers for re-use and the cleaned air returned to the plant. *No material is wasted—all is used, meaning substantial savings. No cleaning-up operation—always a clean plant!*

Self-cleaning by reverse air, the Sly Dynaclone represents the greatest advance ever made in industrial dust collection. Without added motors or blowers, it maintains a constant, uniform suction at dust sources. No shutdowns, no shaking, no wearing of bags. In use since February, 1951, it has operated continuously—*24 hours a day.* Well pleased, The B. F. Goodrich Company has purchased large Dynaclones for three other plants.

THE W. W. SLY MANUFACTURING CO.
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BOOKS . . .

chusetts, Rhode Island, Vermont, and Connecticut creating state agencies for the purpose of fostering industrial expansion through private rather than public credit.

While tax exemptions as such are prohibited by the Texas constitution, it is not unusual for a community to promise non-annexation for a stated period provided a given industry agrees to locate in the vicinity. As a matter of fact, the city administration then serving promised the Southern Alkali Corp. that if its plant would be built near Corpus Christi it would never be taken into the city limits, and although this promise has never been considered to be legally binding on subsequent administration, it has been honored as morally binding by the city. Again, it is not totally foreign to some Texas cities to offer tax concessions for a stipulated number of years to certain industries locating within their boundaries.

Houston is the only city in Texas where an attempt is made to give industry tax advantages by a method of limited purpose annexation.

The statutes providing for limited purpose annexation expressly prohibit city taxation of this area, which is 2,500 ft. from the thread of the ship channel on each side. Any funds paid by the residents of the area to the city of Houston are strictly for services performed.

Heavy industry located near Longview is also outside of the city limits, and Austin, by charter amendment, has adopted a plan of limited annexation which provides that residents of the limited purpose area pay the city only for services received and are not subject to the levy of city taxes. There is no concentration of heavy industry at Austin, but the city has rather consistently followed a policy of not annexing territory until it is able to furnish the annexed area city services.

As a rule, industrial foundations are established as non-profit corporations, composed of and directed by private citizens. In most instances, stock is sold in the corpo-

ration and the funds are used to purchase land, existing buildings, to erect new buildings or plants, to offer loans to companies and the like. Sometimes, instead of the sale of stock, contributions to the foundation are sought. Generally it is hoped by the corporation that funds expended to assist industry will be repaid. This has not always been the case.—*JAL*

Unorthodox Inorganic

THE ACTINIDE ELEMENTS. Edited by Glenn T. Seaborg and Joseph J. Katz. McGraw-Hill Book Co., New York. 870 pages. $11.75.

Reviewed by F. C. Nachod

There is a large segment of inorganic chemistry which is not found in orthodox textbooks. No longer is the periodic table restricted to 92 elements, with the announcement of the discovery of element 100 just a few months ago.

Most of the declassified information on the trans-uranium elements has been widely scattered in the literature. Thus the collection and co-ordination of data on uranium, protactinium, thorium, etc., as well as information on the elements neptunium, plutonium, americium, curium, berkelium and californium will be welcome to many readers.

An impressive roster of contributors from the University of California, Argonne National Laboratory and Los Alamos Scientific Laboratory (R. E. Connick, B. B. Cunningham, R. E. Elson, F. T. Hagemann, J. C. Hindman, H. R. Hoekstra, J. R. Huizenga, E. K. Hyde, A. H. Jaffey, J. J. Katz, L. I. Katzin, W. M. Manning, I. Perlman, G. T. Seaborg, E. Staritzky, K. Street, Jr., A. L. Truitt, W. H. Zachariasen) report authoritatively on the status of our "disclosable" knowledge.

Extensive bibliographies at the end of each of the 20 chapters add even more value to a book that does credit to authors, editors and publishers alike.

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A Better Multiwall Valve Bag FOR LESS!

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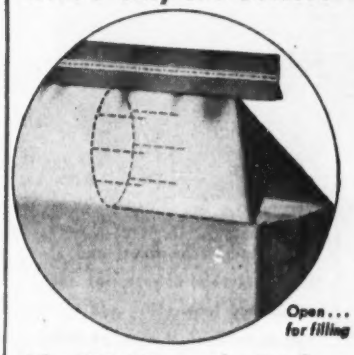
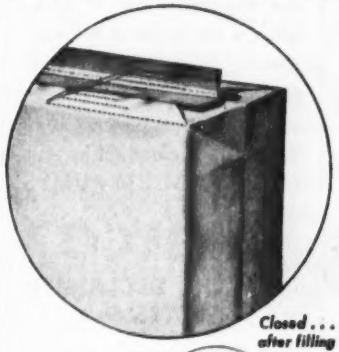
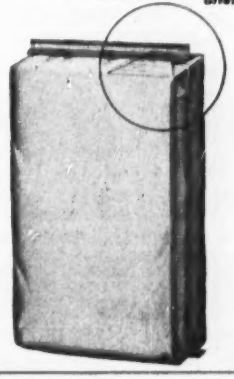


Open... for filling

The FLEX Does the Trick...



Closed... after filling



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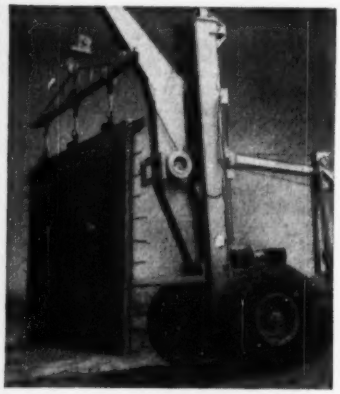
what's NEW in Engineering

A carbon dating process developed by the University of Manitoba is said to make it possible to date – within 10 years of actual age – any matter containing radioactive carbon from as far back as 40,000 years. A liquid scintillator is used. The material to be dated is incorporated in the liquid. There it sets up light flashes which are measured by an electronic eye. The sample is destroyed in the testing process.



Pre-cast, tilt-up walls, soil testing and analysis, uniform spacing of bays and a dead level roof all played important roles in Kaiser Engineers' research, design and construction of Westinghouse's newest – and largest – commercial lighting fixture plant. The result: a building suited in every respect for its intended purpose, and one constructed at an unusually low cost per square foot. For further information on this and other major Kaiser Engineers' projects, write us at the address below.

A cold weather blow torch, weighing just 6½ ounces, is claimed to operate efficiently at temperatures down to –70F. The torch pre-heats its own combustion air and a separate tank supplies fuel.

Widely diversified engineering talents and experience are available to every Kaiser Engineers' project. Departments include civil, structural, electrical, mechanical, architectural, process and production, mining and geology, metallurgical and chemical – and all work closely together. Call or write to Kaiser Engineers Division of Henry J. Kaiser Company, Kaiser Building, Oakland 12, California.

THIS MONTH'S *Recent Books*

Polymer Degradation

A book dealing with two important subjects: the structure of polymers, and the mechanism of their breakdown. All of the papers included are technical and advanced. They were delivered at a symposium held in Sept. 1951 at the National Bureau of Standards. Some of the polymers discussed: polyvinyl chloride, polyacrylonitrile, polythene, polystyrene. 280 pages.

"Polymer Degradation Mechanisms." National Bureau of Standards Circular 525. Superintendent of Documents, Government Printing Office, Washington 25, D. C. $2.25.

Mineral Resources

This booklet consists of three parts: an annual report of the California State Minerologist for the fiscal year July 1952 to July 1953; a comprehensive report on California mineral commodities (production of minerals in 1951, directory of producers of nonmetallic and metallic minerals, directory of mineral dealers and commercial labs); and the third part deals with mines and mineral resources of Amador County, California. 285 pages.

"California Journal of Mines and Geology." Vol. 50, No. 1. State of California, Department of Natural Resources, Division of Mines, Ferry Building, San Francisco 11, Calif. $1.

Occupational Health

This bibliography is directed to persons and organizations concerned with industrial health problems. It presents a comprehensive listing of all Public Health Service publications on occupational health subjects, issued through 1953. 110 pages.

"Bibliography of Occupational Health." Public Health Service Pub. No. 300. Superintendent of Documents, Government Printing Office, Washington 25, D. C. 25c.

Pamphlets

Porcelain Enamels

Engineering applications for porcelain enamels and ceramic coatings have received wide attention recently. Jet burner parts, chemical processing equipment, conveyors, are some of the fields for these materials. Here is a booklet which includes 16 papers recently delivered at an ASTM symposium on porcelain enamel. They discuss such topics as: acid resisting properties, abrasion resistance, guideposts to selecting porcelain enamels and ceramic coatings. 122 pages.

"Symposium on Porcelain Enamels and Ceramic Coatings as Engineering Materials." American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. $2.50.

Vinyl Chloride

Safety data sheet on vinyl chloride. This pamphlet contains the latest information on properties, handling, storage, waste disposal and health hazards. 16 pages.

"Vinyl Chloride." SD-56. Manufacturing Chemists' Association, Inc., 1625 Eye St. N.W., Washington 6, D. C. 25c.

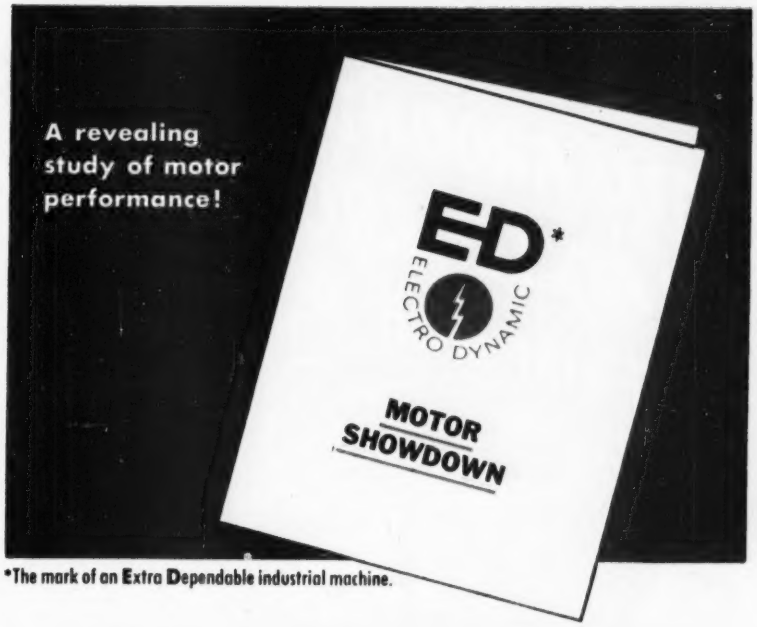
Paint Industry Developments

A valuable digest of technical and commercial developments in the paint industry for the year 1953. Chemical intermediates, dibasic acids, acrylonitrile are discussed; in addition to the references on latex polymers, alkyd resins, lacquers and oils. The volume contains an excellent cross-reference. 228 pages.

"Annual Review of the Paint Industry – 1953." Paint and Varnish Production, 855 Sixth Ave., New York 1, N. Y. $3.50.

Cane Products Composition

The authors have critically surveyed the chemical literature on components of cane juice and molasses. They've come up with this



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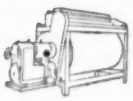
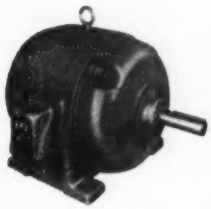
THIS CANDID REPORT UPSETS MANY IDEAS ON MOTOR SELECTION FOR CHEMICAL MACHINES





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The results of comparative performance tests* on production line models of different makes of electric motors are reported concisely in a new booklet entitled **"MOTOR SHOWDOWN"**. The facts revealed are of real importance to anyone concerned with motor selection, because the makes of motors tested power over 75% of the electrically operated machinery in *your* industry. Mail the coupon below for your copy.

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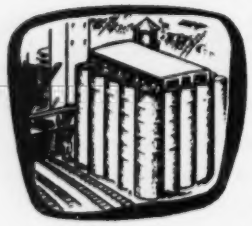

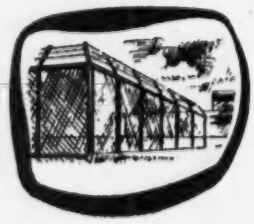

Your maintenance costs go down and plant efficiency goes up when you use Aluminum Paint in your maintenance program. For, remember the paint is only a small part of the cost of painting.

It's the longer life, lower overall cost and the many other values that make Aluminum Paint the best maintenance buy. Resistant to moisture and heat, reflecting light and heat rays, reducing storage tank and other evaporating losses, brightening plant interiors—these and a host of other extra values and added protection are provided.

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PAMPHLETS . . .

monograph which records all the components of these two materials that have been positively identified by modern chemical analysis. 24 pages.

"Composition of Cane Juice and Cane Final Molasses." By W. W. Binkley and M. L. Wolfrom. Sugar Research Foundation, Inc., 52 Wall St., New York 5, N. Y. No charge.

Petroleum Products Tests

A booklet of ASTM standard and tentative methods of test, and specifications on petroleum products and lubricants. Some typical items: ASTM engine test methods for rating fuels, acetylene in butadiene. 890 pages.

"ASTM Standards on Petroleum Products and Lubricants." American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. $3.

Economic Almanac

A handbook of statistical and economic data useful to people concerned with current economic problems. Population, consumption, prices, living standards and public finance statistics are included. 624 pages.

"The Economic Almanac 1953-1954." Thomas Y. Crowell Co., 432 Fourth Ave., New York 16, N. Y. $3.95.

Fretting Corrosion

A symposium on fretting corrosion—surface damage that occurs when two solid surfaces are contacted under relatively high loads and small vibratory motions. Consists of five papers including one on test equipment. 84 pages.

"Symposium on Fretting Corrosion." American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. $2.

Industrial Directory

This book lists about 15,000 industrial firms in New Jersey—and in addition gives information on the state's counties and towns, tax

and insurance rates. Firms listed alphabetically, geographically and by product. 1,100 pages.

"1954-55 New Jersey Industrial Directory." New Jersey Industrial Directory, Hudson Dispatch Bldg., 400—38th St., Union City, N. J. $25.

Industrial Hygiene

Transactions of the Industrial Hygiene Foundation's 18th annual meeting. Some topics: industrial noise, problems of human relations in the industries. 85 pages.

"Industrial Hygiene Foundation – 18th Annual Meeting." Bulletin No. 26. Industrial Hygiene Foundation of America, 4400 Fifth Ave., Pittsburgh 13, Pa. $1.50.

Fluid Gasification

This bulletin reports on a study of the application of fluid cracking techniques to produce utility gas from oil. Studies were carried out in small-scale laboratory units. 48 pages.

"Fluid Gasification of Oil." Research Bulletin No. 16. Institute of Gas Technology, 17 West 34th St., Technology Center, Chicago 16, Ill. $5.

Industrial Survey

Survey of what industry thinks it needs in the way of new manufacturing equipment and processes. Over-all figures are broken down to show variations by plant size. 16 pages.

"Are YOU Ready to Meet Stiff Competition." Denham & Co., 925 Book Building, Detroit 26, Mich.

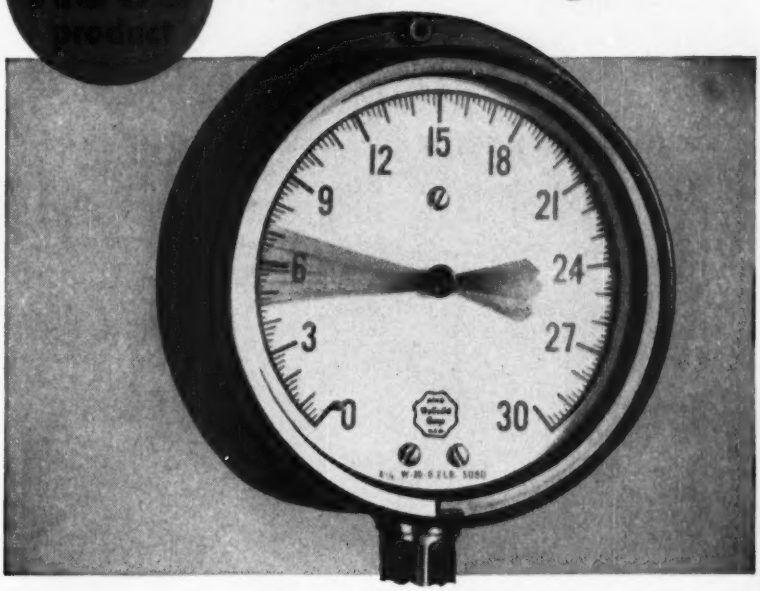
Fire Resistance Ratings

A pamphlet of fire resistance ratings put out by the Board of Fire Underwriters. Contains tables of ratings of beams, girder and truss constructions. 48 pages.

"Fire Resistance Ratings." National Board of Fire Underwriters, 85 John St., New York 38, N. Y.

ACCO product

Helicoid Gages



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Lebanon steel castings in the pumps for this extraordinary machine that cold rolls tubing up to 18" O.D., were engineered and built for enduring service.

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THIS MONTH'S

Firms in

New Facilities

Tenney Engineering, Inc., Union, N. J.—A new plant devoted exclusively to the manufacture of environmental equipment is now carrying on full-scale operations. This expansion marks the third in recent years. The one-story structure is located on a 7-acre site to allow for future expansion.

Marlow Pumps, Div. of Bell & Gossett Co., Ridgewood, N. J.—A branch manufacturing plant at Longview, Tex., has been established. All operations for the production of Marlow engine-driven self-priming and end-suction centrifugal pumps will be transferred from the firm's facilities in Arkansas.

Martin-Ruegg Brass & Aluminum Foundry—Construction has begun in Gardena, Calif., on a factory and office building for the firm's Die-casting Div. Customer molding for western industries will be done at the new plant.

Foxboro Co., Foxboro, Mass.—Erection of a branch factory in Dallas, Tex., will double the facilities of the firm in that area. Foxboro manufactures industrial instruments for process measurement and control for the petroleum refining, natural gas, chemical and petrochemical fields.

Sam Tour & Co., Inc., New York A Titanium Analysis Section has been created by this firm due to the extensive use of this metal in industrial applications. The

firm has completed nearly four years of work under research and development contracts from the Ordnance Corps., U. S. Army.

The Raymond Corp., Greene, N. Y.—Plant expansion program is planned by this manufacturer of electric fork lift trucks, hand pallet trucks and allied materials handling equipment. A new single-story structure totalling 55,000 sq. ft. of space will house plant and office facilities.

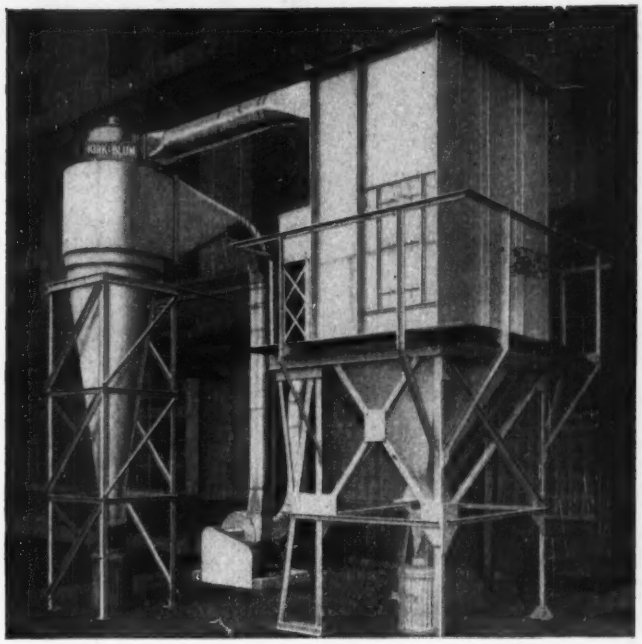
The Eaton-Dikeman Co., Filtertown, Mt. Holly Springs, Pa.—A New York City office has been opened, at 50 Church St., to take care of customer service in the industrial area from New England to the New Jersey area.

Zenith Plastics Co., Gardena, Calif.—Consolidation of all the firm's aircraft engineering and fabrication facilities into a new division to be known as Zenith Aircraft. The company is producing plastic fuselage assemblies for Lockheed bombers.

Cambridge Corp., Cambridge, Mass.—A 40,000 sq. ft. industrial plant, located on the outskirts of Lowell, Mass., has been leased by the firm. The building and 6½ acre site were formerly owned by the New Industrial Plants Foundation of Lowell, Inc.

International Metal Hose Co., Detroit—Completion of an expansion program has resulted in increased production. Metal hose can now be supplied in three different weights, and is available in galvanized steel, brass, bronze, stainless steel and aluminum.

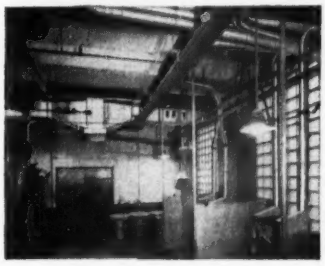
Dresser Industries, Inc., Dallas, Tex.—A purchase agreement with Industrial Sites, Inc., Tulsa, Okla., for a 15 acre site in Tulsa, has cleared the way for further expansion by the firm. The $1 million, long-range expansion



pharmaceutical manufacturer finds

KIRK and BLUM DUST CONTROL

"just what the doctor ordered!"



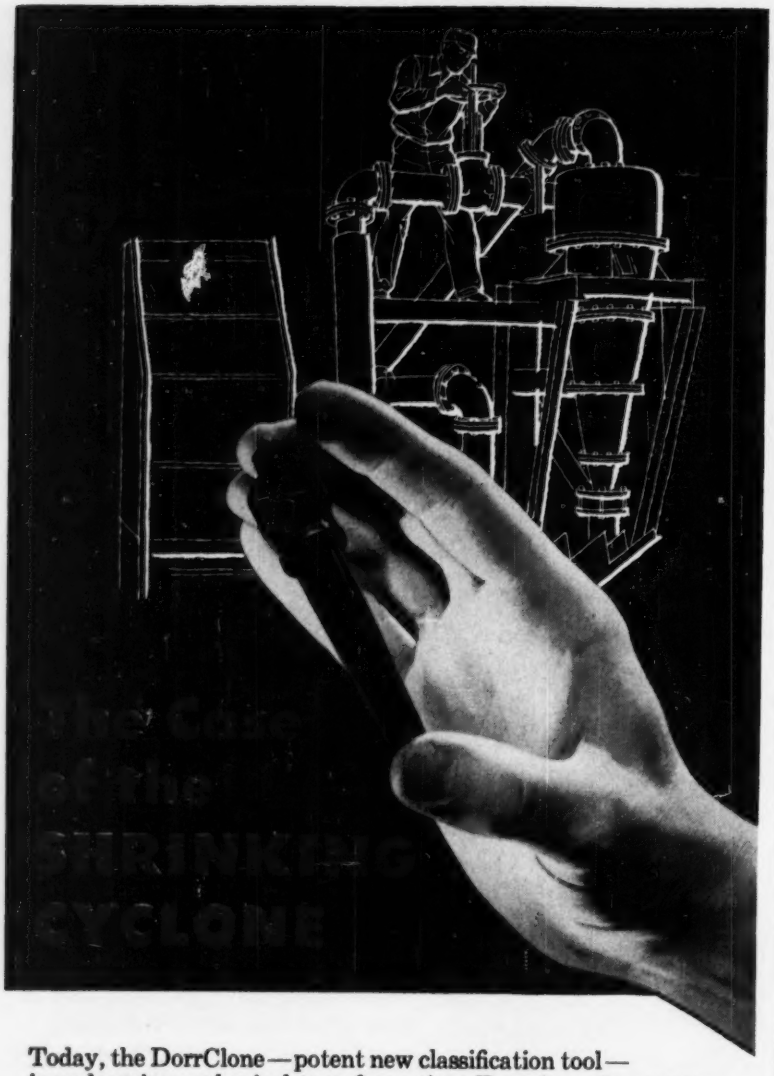
To maintain rigidly controlled and conditioned plant atmosphere, air returned from cleaning operation is heated or cooled as required.

To insure, in all manufacturing steps, the purity of The Wm. S. Merrell Company's products, Kirk & Blum Dust Control Systems were installed by this well known pharmaceutical manufacturer. Dust is eliminated at its source to meet the plant's strict requirements. Since the building is air conditioned, cleaned air is tempered (warmed or cooled) before it is returned to the plant.

Whatever your problem, put it up to experts in air handling . . . KIRK & BLUM—with over 46 years' experience in Dust and Fume control. For illustrated literature, write to: The Kirk & Blum Mfg. Co., 3208 Forrer St., Cincinnati 9, Ohio.

KIRK AND BLUM
DUST CONTROL

THE KIRK AND BLUM MANUFACTURING COMPANY
3208 FORRER STREET CINCINNATI 9, OHIO



Today, the DorrClone—potent new classification tool—is undergoing a physical transformation. Experience has proven that decreasing its diameter increases the fineness of the separation made. Result... the pencil-size TM DorrClone shown above.

These bakelite midgets, nested 32 to a housing, are doing big things in filtrate clarification and fine size classification in the 2 to 20 micron range. Clays, pharmaceuticals, fillers, pigments, talc, grinding compounds — all can be economically processed by these 10 mm TM's or their companion 15 mm units of molded rubber.

The case of the shrinking cyclone is a good example of the constant evolution of Dorr machines and methods. If you have a problem involving the separation of finely divided solids in suspension, the use of ion-exchange, or fluid techniques, the chances are good that we can be of service to you through our worldwide organization.

DorrClone is a trademark of The Dorr Co., Reg. U.S. Pat. Off.

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Better Tools TODAY to meet Tomorrow's demand

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THE DORR COMPANY • ENGINEERS • STAMFORD, CONN.
Offices, Associated Companies or Representatives in principal cities of the world.

FIRMS . . .

program will provide increased office, servicing and plant facilities.

American Can Co.—Construction has been launched on the firm's new 60,000 sq. ft. plant at Denver, Colo. The plant will have an annual rated capacity of 125 million containers to serve canning centers in the West. It also will provide a Rocky Mtn. warehousing point for paint and specialty cans.

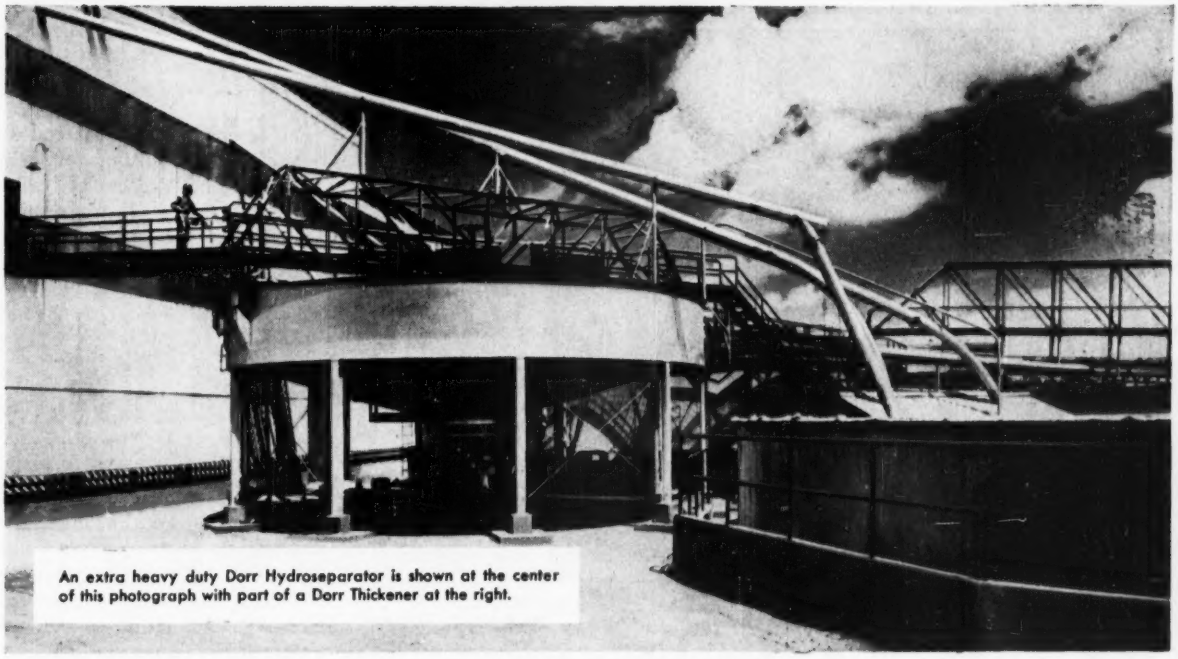
Sun Oil Co.—New additions to the firm's facilities at Marcus Hook, Pa. Catalytic Construction Co. will construct a houdriflow catalytic cracking unit and a houdriformer catalytic unit. The latter unit is a part of a program undertaken by the firm to improve the quality and octane of Sun's motor gasoline.

E. I. Du Pont de Nemours & Co., Wilmington, Del.—A new laboratory building for expanded research on safe-guarding the health of its employees and consumers. The $2 million structure provides enlarged facilities for the firm's Haskell Laboratory for Toxicology and Industrial Medicine.

American-Marietta Co.—Resin capacity of the firm's Seattle plant will be increased 25% under an expansion program costing more than $75,000. An 18 x 30 ft., 3-storey steel frame addition to the reactor building will house another resin kettle.

Metalweld, Inc., MW Protective Coatings Div., Philadelphia—Completion of a shed over the railroad siding at the Scotts Lane Plant, will permit greater efficiency in the application of sprayed zinc and aluminum, epon and vinyl linings to the interior of tank cars to protect their contents from contamination.

The Powerad Co., New York—Expansion program of the Federal Latex Corp., Brooklyn, N. Y.,

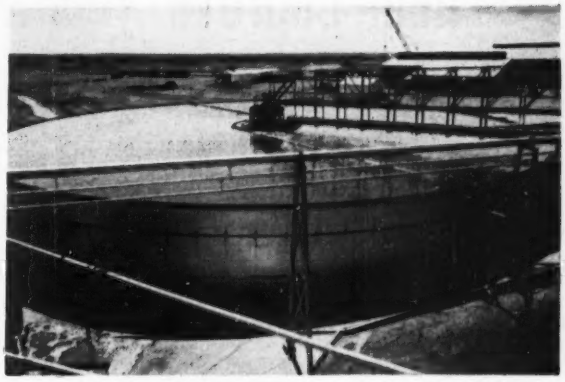


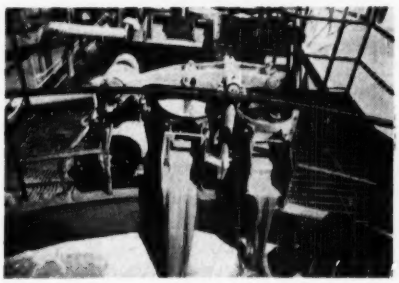
An extra heavy duty Dorr Hydroseparator is shown at the center of this photograph with part of a Dorr Thickener at the right.

Potash Production in the Carlsbad Basin

Dorr Classifiers, Hydroseparators and Thickeners play a key role at Southwest Potash Corporation's new plant in Carlsbad, New Mexico. Incorporating the latest developments in chemical and metallurgical beneficiation techniques, the flowsheet includes crushing, open-circuit grinding, flotation, centrifuging, washing and thickening.

In the Carlsbad Basin, the South African Gold Fields or the Mesabi Range . . . wherever a process involves the handling of finely divided solids in liquids . . . these basic Dorr machines are an integral part of the plant flowsheet. For information on the complete Dorr equipment line, write for a copy of Bulletin No. 7002. The Dorr Company, Stamford, Conn.

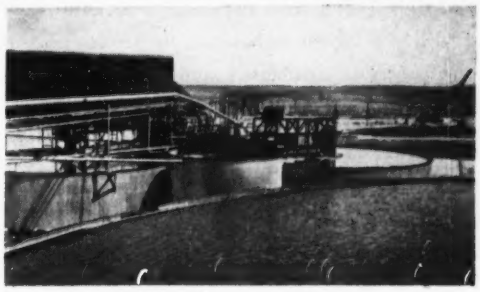




This 180 ft. Dorr Thickener, equipped with skimming arms, thickens slimes ahead of a CCD System.

One of the Dorrco Type W's pumping Thickener underflow.

View from tailings Thickener walkway with the smaller Dorrs in background.



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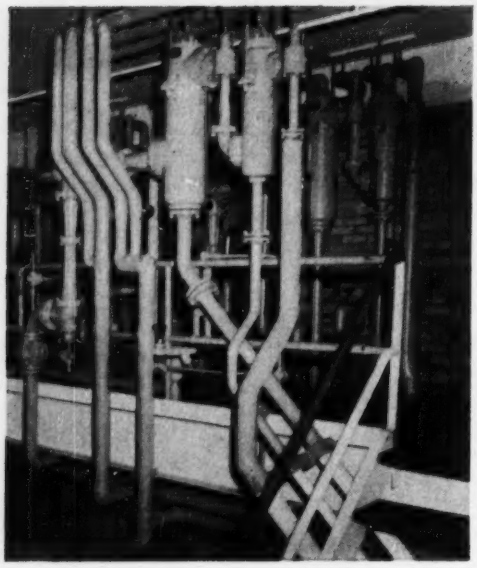

Photo Courtesy of Hoffman LaRoche Inc., Nutley, N. J.

LET C-R EVACTORS help improve your health

This illustration shows two 4-stage Evactors in the plant of a leading manufacturer of vitamins and other pharmaceuticals. The same plant uses numerous other C-R Evactors of different types—as do the majority of manufacturers in this important field—for many different processes, including deodorizing, distilling, drying, refrigeration, etc. They are as simple as the valves that turn them on, yet maintain absolute pressures down to a small fraction of 1 m.m. absolute where steady, dependable vacuum is extremely important.

This steady, dependable vacuum is contributing to the improved health of our population by helping to supply purer and more potent vitamins, antibiotics and other pharmaceutical products. It is contributing indirectly to the health of many operators and executives in other manufacturing industries, by minimizing worry over vacuum problems. This also applies to Jet Mixers, Jet Heaters, Jet Absorbers, Jet Scrubbers, Jet Pumps, Jet Condensers and Barometric Condensers.

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New York Office: 17 John St., New York 38, N. Y.

CHILLVACTORS • STEAM JET EVACTORS • CONDENSING EQUIPMENT

FIRMS . . .

will be completed by the end of the year. Installation of new compounding and storage tanks will more than triple present production capacity.

France Packing Co., Philadelphia–A modern plant has been completed to facilitate the firm's expansion of activities in the field of bake-lite piston rings and valve disc manufacturing.

Denver Equipment Co., Denver–A Salt Lake City, Utah, office has been opened to serve consumers of Denver's line of industrial equipment.

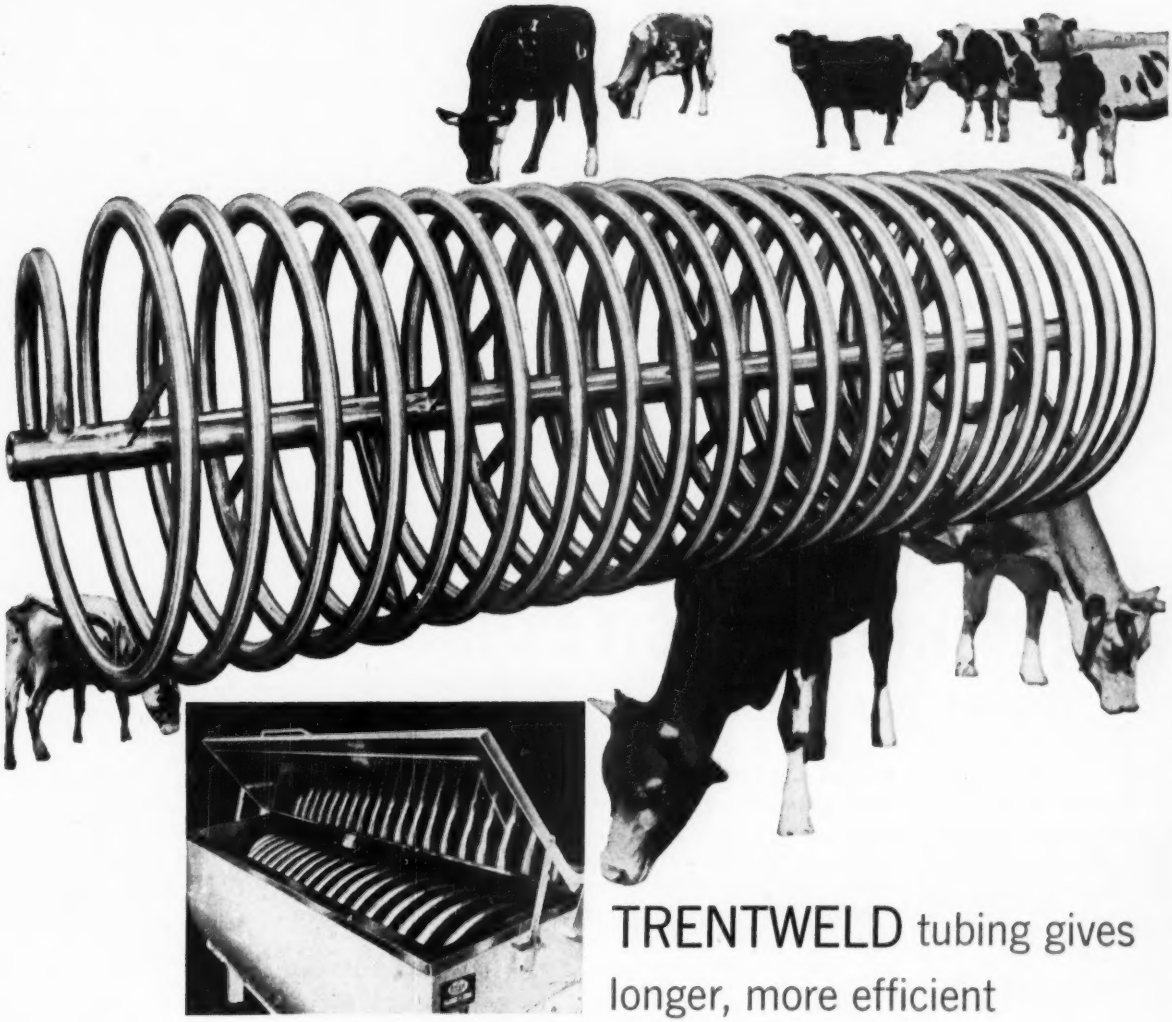
Mutual Chemical Co. of America–New office facilities have been opened, by this manufacturer of chromium chemicals, at 99 Park Ave., New York 16, N. Y.

New Lines

Hamilton Rubber Mfg. Corp., Trenton, N. J.–Dacro-flex fire hose has been added to its line of industrial rubber products. The new line employs a chemically produced polyester fiber as filler cord to reinforce the hose. The result is a more flexible, less bulky piece of equipment than conventional types of fire hose.

Societe Rhone-Poulenc–Commercial production of phenol from cumene has begun at the firm's plant in Roussillon, France. A producer of phenol for 40 years, the company is the first in France to use cumene as the starting material. Production now averages 60,000 pounds daily.

Sage Equipment Co., Buffalo, N. Y.–A wheel rail conveyor is added to the firm's line of wheel



TRENTWELD tubing gives longer, more efficient operation in OVL-KOIL pasteurizer

The unique OVL-KOIL pasteurizer coil illustrated, is made of TRENTWELD stainless tubing. By forming the coil in an oval shape General Dairy Equipment, Inc., increased its length 10% without any increase in pasteurizer size or sacrifice of space between loops.

This extra coil area speeds up the pasteurization process, increases the efficiency of heating and cooling mediums, and gives greater heat transfer efficiency.

But this is just one of thousands of applications where TRENTWELD tubing has helped make products last longer and operate more efficiently. When you have an application calling for stainless or high-alloy tubing it will pay you to look to TRENTWELD. Trent offers the widest range of tubing sizes and finishes in the industry . . . in standard sizes from ⅛″ to 40″ O.D. – larger sizes on special order. And remember, you just can't buy better tubing than TRENTWELD.

TRENTWELD

STAINLESS STEEL TUBING

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NETTCO
ENGINEERED AGITATOR
speeds gas dispersion process
Another product of Nettco equipment and Nettco engineering — a tank-top Model WT-47 Agitator Drive with 15 HP explosion proof motor driving two Nettco split turbines on a shaft over 17 feet long! Specifications allowed for no internal tank bearings. Solids would run up to 40% maximum . . . operating pressures would range all the way from 30 in. vacuum to 39 psig. The problem of designing, engineering, and building the agitator to do this job was entrusted to Nettco.
Result . . . a Nettco engineered product from top to bottom . . . designed and built for efficiency, durability, and ease of service and inspection. Because all major components are standardized Nettco units, the customer gained important economies, despite the special features of the installation.
Let Nettco help solve your agitating problems! We'll be glad to quote on your requirements. New England Tank & Tower Company, 87 Tileston St., Everett 49, Mass.
NETTCO
ENGINEERED AGITATION

FIRMS . . .

roller and power driven conveyors. The new line is a single rail conveyor unit which is easily installed and adapted to various industrial uses.

New Representatives

Plax Corp., West Hartford, Conn., has named Peter & Co., Louisville, Ky., as distributor in western Kentucky and southern Indiana for its line of plastic squeeze bottles. In addition, the firm has opened branch offices in San Francisco and Dallas.

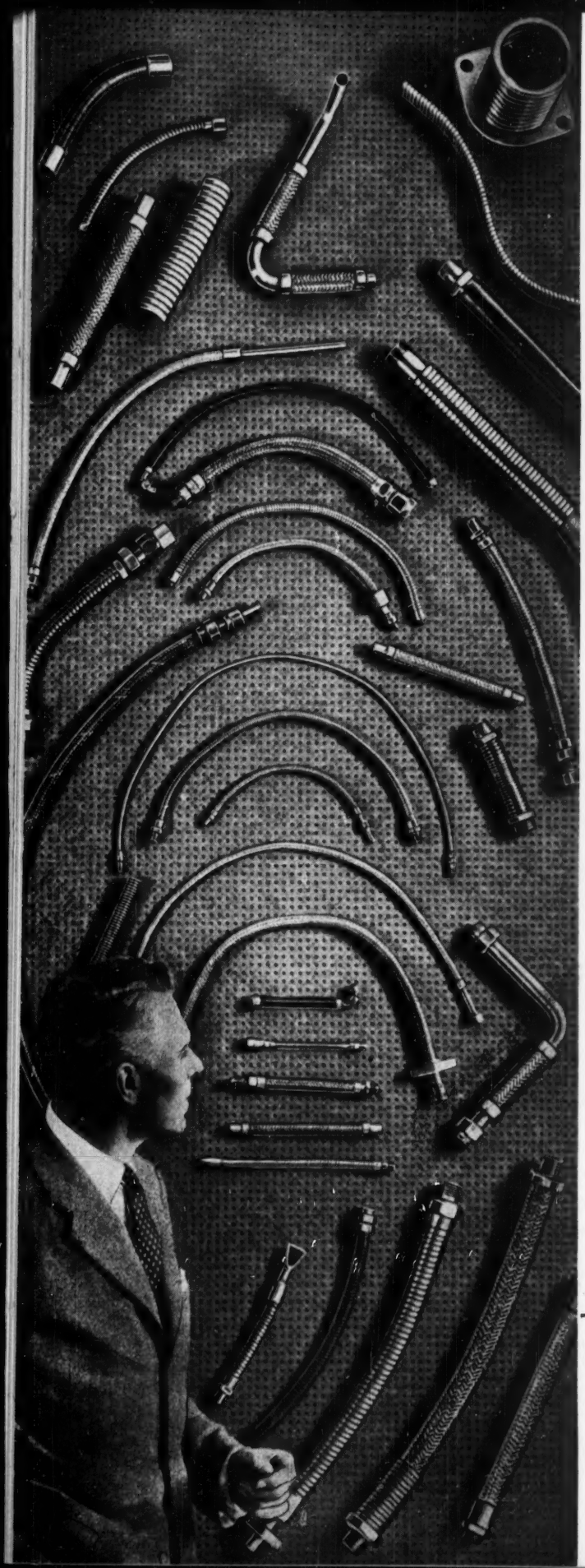
Ampco Metal, Inc., Safety Tool Div., Milwaukee, has appointed the Max Weiss Co., and Persingers, Inc., as stock distributors of the full line of Ampco safety tools. The former company will represent Ampco in Milwaukee; the latter, in Charleston.

Black, Sivalls & Bryson, Inc., Kansas City, has chosen two new manufacturer's representatives. Fluid Controls Co., Inc., Philadelphia, will cover the District of Columbia, Maryland and Virginia; Berry Ervin Engineering Co., Minneapolis, will handle the firm's line in Minnesota and the Dakotas.

The Annin Co., Los Angeles, manufacturers of Annin domotor valves and other process equipment, will be represented by Ward K. Stallings Co., Atlanta, in Georgia, parts of Tennessee and northeren Alabama, and by Frank A. Thomas Co., Spring Hill, Ala., in Alabama and Florida.

Preferred Utilities Mfg. Corp., New York, has appointed the H. A. Pietsch Co., Pittsburgh, as sales and engineering representative for the firm's line of unit steam generators in western Pennsylvania, West Virginia and eastern Ohio.

Beaumont Birch Co., Philadilphia, manufacturers of a variety of coal, ash and chemical bulk han-



Special design of flexible connectors costs you nothing at American

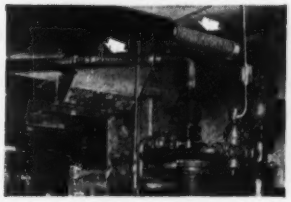
Hard to believe? Then look at the flexible connectors at left. Each was designed by *American*, complete with special fittings, to meet specific requirements. The design for each connector *costs not one cent extra.*

Vibration. Movement. Misalignment. Cramped space. Perhaps one of these is your connector problem. Or maybe it's conveying steam, water, oil, and other liquids, semisolids or gases under one or more of these conditions. Whatever it is, "American" engineers and American Flexible Metal Connectors can help you solve it.

These connectors are available in bronze, brass, aluminum, steel and stainless steel, in a wide range of ID's. End fittings are adaptable to all types of connections.

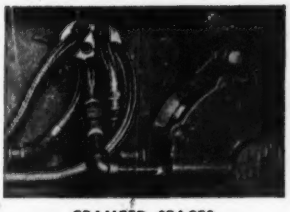
Check with American *first* when you plan a new installation or want to do away with unsatisfactory connections. You'll save time and money. Remember—special design costs you *nothing* at American. 64100

Here's the easy way to solve problems of . . .

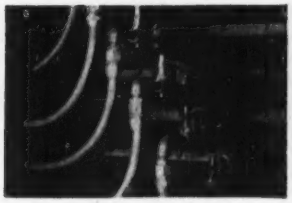


VIBRATION

MISALIGNMENT



CRAMPED SPACES



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flexible metal hose and tubing

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The American Brass Company, American Metal Hose Branch
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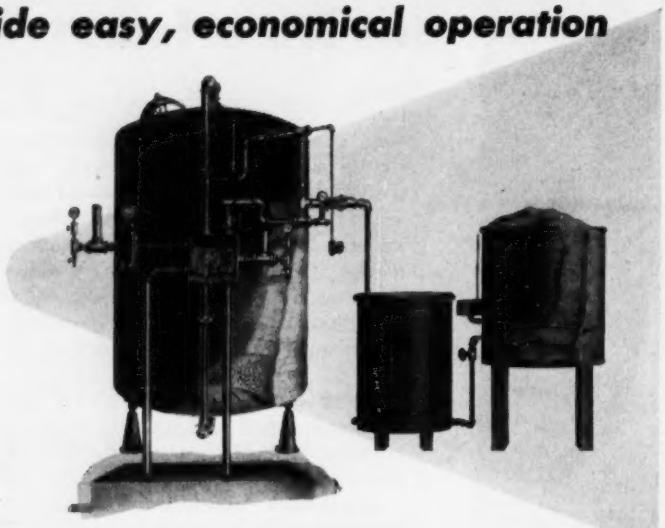
Cochrane ZEOLITE SOFTENERS

provide easy, economical operation



The Cochrane Hydromatic Single Control Valve provides positive, accurate control of all phases of the softening and regenerating cycle.

It is so simple to operate that no technical knowledge of the softening process or the equipment is required. High quality effluent is thus assured at a minimum cost and maximum delivery.

Cochrane engineers and manufactures every type of precipitation and ion exchange water conditioning equipment, thus assuring you unbiased recommendations for equipment best suited to your requirements. Cochrane's *complete* service provides single responsibility for engineering, fabrication and continued satisfactory operation.

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FIRMS . . .

dling equipment, has selected D. J. McAllister Boiler Works, Chicago, and Ross Irwin Equipment Co., St. Louis, as representatives in their respective locations.

Conoflow Corp., Philadelphia, manufacturers of pneumatic final control elements, has selected Cyberno Products Co., New York, as its exclusive representatitve in the New York area. In Cleveland, the firm will be represented by Chemical Pump & Equipment Corp.

Transmission Equipment Co., Inc., New York, an engineering firm which specializes in heavy machinery, equipment, and components, has appointed Warren M. Pike Assoc., Inc., Boston; Harry Holland & Son, Inc., Detroit; Eastern Brace-Mueller-Huntley, Inc., Albany; and Rutan & Co., Philadelphia.

General Electric Co., Carboloy Dept., Detroit, has named the Alden Supply Co., Inc., Philadelphia, an authorized distributor for its line of standard cemented carbide tools and blanks, carbide-tipped masonry drills and diamond wheel dressers.

Parker Appliance Co., Cleveland, has named the B. W. Rogers Co., Cleveland; Ritter Engineering Co., Pittsburgh; and Hope Rubber Co., Fitchburg, Mass., as distributor for its line of Hoze-lok fittings. In addition, the Korody Marine Corp., Hawthorne, Calif., has been appointed export distributor.

Alloy Precision Castings Co., Cleveland, has selected the Gibney-Coffman Corp., Buffalo, as exclusive sales agents in northwestern New York, for mercastings produced by the firm.

American Alcolac Corp., Baltimore, has selected the North Coast Soap & Chemical Co., as distributor of its line of industrial chemicals and detergents. American Alcolac's products are being

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VVF pigments will reduce your grinding and dispersing time in paints and allied products as much as 75%.

VVF pigments give you brighter mass color, stronger tint, increased hiding power, and higher gloss than standard grind pigments.

VVF pigments now available are—Raw and Burnt Siennas, Raw and Burnt Umbers, Metallic Browns, Red Iron Oxide, and Primer Pigments.

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Company_____

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FIRMS . . .

used by major companies for textile processing, cosmetics and household detergents.

Librascope, Inc., Glendale, Calif., has appointed Davidson & Hemmendinger as northeastern sales represenative to handle Librascope's line of mechanical and electrical analog computers, digital computers, input-output devices, recording instruments and components. The new sales agent is located in Easton, Pa.

Hoke, Inc., Englewood, N. J., manufacturers of a complete line of small valves and accessories for fluid control, has appointed the Joseph H. Bertram & Co., Inc., Brookline, Mass.; Crawford Fitting Co., Cleveland; and W. H. Curtin & Co., Houston, as new distributors.

Clark Equipment Co., has granted a franchise for the sale and service of Clark industrial fork-lift trucks to Erie Industrial Trucks, Inc. In addition to the regular line of Clark materials handling equipment, the new dealer will also handle the high capacity fork-lift trucks formerly manufactured by the Ross Carrier Co.

New Names

Will Corp., Rochester, N. Y., has changed the name of its Atlanta laboratory supply house from "Southern Scientific Co., Inc." to "Will Corp. of Ga." In addition, its "Buffalo Apparatus Corp." will now be known as "Will-Buffalo, Inc."

New Companies

Kenneth S. Valentine—A new manufacturers' representative firm has been set up by the former sales manager of the Turbo-Mixer Corp. and N. Y. manager of the Patterson Foundry & Machine Co. Initially, the firm will represent the line of homogenizers and high pressure pumps of the Manton-Gaulin Co., Everett, Mass., and The Stevenson Co.'s line of dry and liquid mixers, dissolvers, ball

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Tank Gauge

- FOR GAUGING LIQUIDS OF ALL KINDS
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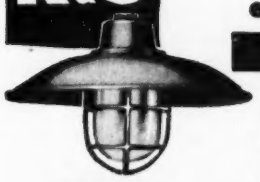
...3 Complete Lines meet every safety lighting need!



VAPORTIGHT

For efficient illumination and maximum indoor and outdoor protection against non-inflammable gases, vapors, dusts and moisture. A complete line available in pendent, ceiling and bracket types from 15 Watts through 500 Watt sizes. Bases remain vaportight when globes are removed or broken in service.

WRITE FOR CATALOG No. 9048-

EXPLOSION-PROOF

CLASS I, GROUPS C & D

For greater safety in hazardous locations wherever flammable materials are made or used. A complete line is available in pendent, ceiling, bracket and hand types—from 100 Watts through 500 Watt sizes. Standard conduit bases permit interchangeability of reflector globe assemblies.

WRITE FOR CATALOG No. H-47-

DUST-TIGHT

CLASS II, GROUPS E, F & G AND CLASS III

For hazardous locations where flammable or explosive dusts are present. Streamlined design prevents dangerous accumulation of dust particles. Two exclusive design features facilitate easy cleaning and relamping. Standard pendent and junction box bases accommodate any style of fixture—globe—assembly interchangeably in either 100 Watt or 200 Watt sizes.

WRITE FOR DATA SHEET No. 7151-5

F4

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DENVER EQUIPMENT

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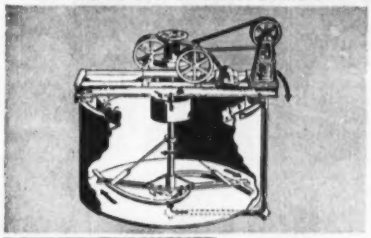
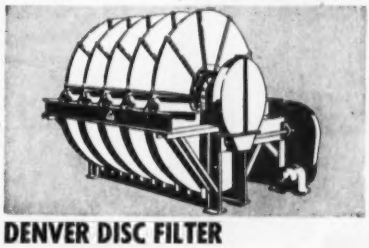


DENVER THICKENER

Size: 6' diameter to 60' diameter.

Features: Beam superstructure, spiral rakes, cut gears in integral lift reducer.

Price examples, with steel tank less drive. FOB Denver.		
	8' dia. x 6'	$1427.00
	20' dia. x 10'	3476.00
	30' dia. x 10'	6959.00

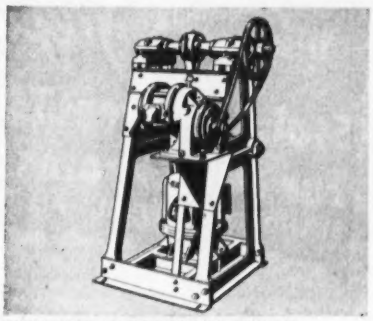


DENVER DISC FILTER

Size: 2', 4' and 6' dia. 2 to 8 disc.

Features: Oversize center shaft, simple renewable automatic valve.

Price examples, less drive and vacuum equipment. FOB Denver.		
	2' dia. x 2 disc.	$1573.00
	4' dia. x 3 disc	2272.00
	6' dia. x 4 disc.	4202.00



DENVER DIAPHRAM PUMP

Size: 1" Simplex to 6" Quadruplex.

Features: Adjustable stroke, molded rubber valve seats, positive action.

Price examples, less motor. FOB Denver.		
	2" Simplex	$ 406.00
	4" Duplex	824.00
	6" Duplex	1914.00

DECO FLOTATION ENGINEERS — DENVER EQUIPMENT COMPANY

DENVER EQUIPMENT COMPANY

"The firm that makes its friends happier, healthier and wealthier"

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4114 Empire State Bldg.
Phone Chickering 4-6510

Toronto 1, Canada
220 Bay Street
Phone Empire 3-8836

OFFICES IN EL PASO, SALT LAKE CITY, MEXICO, D.F., VANCOUVER, LONDON, JOHANNESBURG.

Technical Bulletins on Request

for Pumping SULPHUR

Request BULLETIN V-837

FIG. 19.478

This TABER centrifugal, Vertical Pump was designed to handle molten sulphur. Note the massive construction. Supporting the suspended pump from channel steel permits the use of an open shaft. This is especially desirable for molten sulphur.

Steam jacketed discharge pipe keeps molten materials from solidifying.

Pump operates efficiently at the relatively slow speed of 1750 r.p.m. (We consider 3600 r.p.m. prohibitive because molten sulphur has no lubricating properties.)

Write us the Head, and gpm you wish to handle together with the depth of your sulphur pit, and we shall send further information, with BULLETIN V-837.

TABER PUMP COMPANY
294 ELM STREET · BUFFALO 3, N. Y.

G-779

Est. 1859

TABER PUMPS

THERE ARE Filpaco
Stainless Steel TANKS
For YOUR Processing
STANDARD · SPECIAL · ALL TYPES

Your inquiry will receive immediate attention.

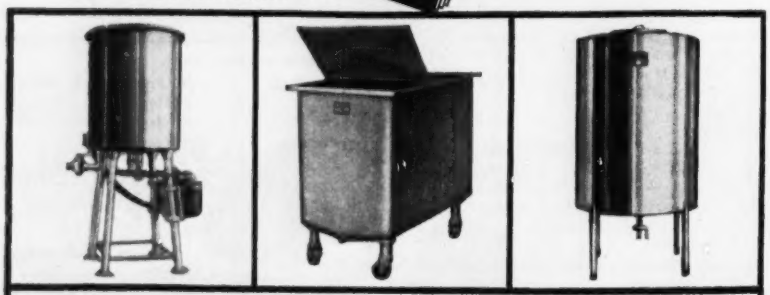
WRITE FOR ILLUSTRATED LITERATURE TODAY!

Get the right tank . . . we maintain stock or fabricate to special designs for your particular need.

Any size . . . any capacity up to 3000 gallons. Horizontal, vertical, rectangular, with side, bottom or top entering agitators.

Also jacketed construction for heating or cooling; insulated.

Accessories: level gauges, thermometers, special covers, special fittings, etc.



FILPACO INDUSTRIES
THE FILTER PAPER COMPANY
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FIRMS . . .

mills and other chemical process equipment. The founder was the first president of the Chemical Equipment Sales Engineers Ass'n of N. Y. and co-author of the mixing section of Perry's *Chemical Engineers' Handbook*.

The General Tire & Rubber Co.— The result of the merger of the Textileather Corp., Toledo, and the Bolta Corp., Lawrence, Mass. The merger establishes General Tire as the world's largest manufacturer of vinyl plastic sheeting and vinyl film.

Monsanto Chemical Co. and Farbenfabriken Bayer Aktiengesellschaft of Leverkusen, Germany, are planning to organize a jointly-owned company in this country for the production of isocyanate chemicals. Isocyanates used in the production of rigid and flexible porous plastics, new synthetic rubber formulations, fibers, adhesives as intermediates in making other chemical compounds.

New Locations

Rector Mineral Trading Corp., New York, has moved its regional office to 551 Fifth Avenue, New York 17, N. Y.

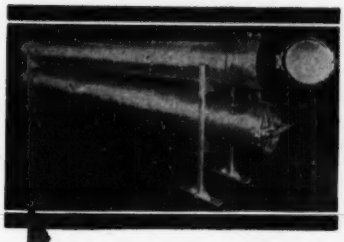
Commercial Solvents Corp., New York, has relocated its St. Louis office at 7890 Folk Ave., in that City, to provide more efficient service to consumers of its methanol, ethyl alcohol, ammonia, methylamines and other chemicals for industry.

Surface Combustion Corp., Toledo, Ohio, has moved its Chicago Industrial Furnace Div. office from Room 1270, 122 So. Michigan, to Park Ridge Federal Bank Bldg., 116 So. Prospect, Park Ridge, Ill.

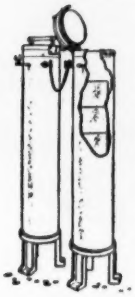
Bailey Meter Co., Cleveland, manufacturers of industrial instruments and automattic control equipment, has moved its Seattle district office to larger quarters. The new address is 200 Broadway, Seattle 22, Wash.

A DEPENDABLE SOURCE FOR INERT GAS

DRY ICE CONVERTERS



No Operating Costs! Easily Cleaned!



Dry Ice Converters are A.S.M.E. code pressure vessels especially adapted to charging with full 50-lb cakes of solid CO_2. They may be located any place in a plant, connected by pressure piping to use area for the gas.

They require no fuel, no electricity, no refrigeration. There are no operating costs! Because they are full opening, they are easily inspected and cleaned. They are ideal for either stand-by or continuous use. A variety of sizes are available for either horizontal or vertical installation.

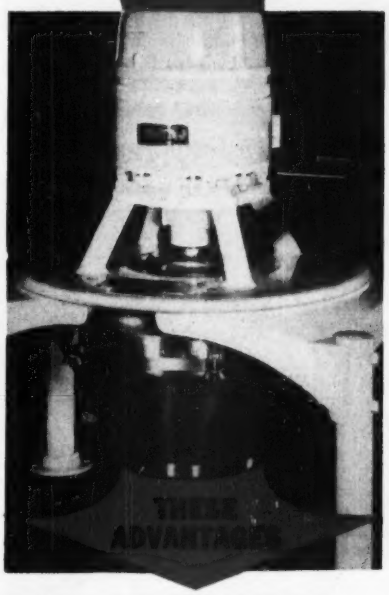
Write for price list and folder giving complete information

DRY ICE CONVERTER CORP. TULSA, OKLAHOMA

DRY ICE CONVERTER CORPORATION

Dept. C., Box 1652, Tulsa, Okla.

"ENTOLETER" HIGH SPEED MIXER



...for

- complete dispersion of dissimilar solids...solid-liquid systems...free-flowing liquids
- special applications in which dispersion and particle size reduction are to be accomplished simultaneously

The "ENTOLETER" HIGH SPEED MIXER corrosion resistant material (stainless... monel... chrome plate)

LOWER COST ... high production rate per horsepower used

BETTER QUALITY ... high speed centrifugal action breaks up pockets or agglomerates of unmixed ingredients, producing a homogeneous blend

COMPACT INSTALLATION ... requires less than 6 square feet floor area

SIMPLIFIED MAINTENANCE .. equipment designed to facilitate cleaning ... discharge hopper and mixing rotor completely demountable

Additional information concerning flow rates to **40,000 pounds** per hour supplied upon request ... write

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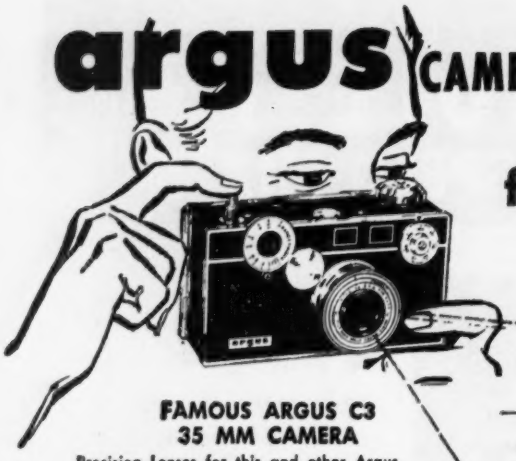
The Safety Car Heating and Lighting Company, Inc.
1197 Dixwell Ave., New Haven 4, Connecticut

The trademark "ENTOLETER" is your guarantee of complete satisfaction

argus CAMERAS, INC., ANN ARBOR, MICH.

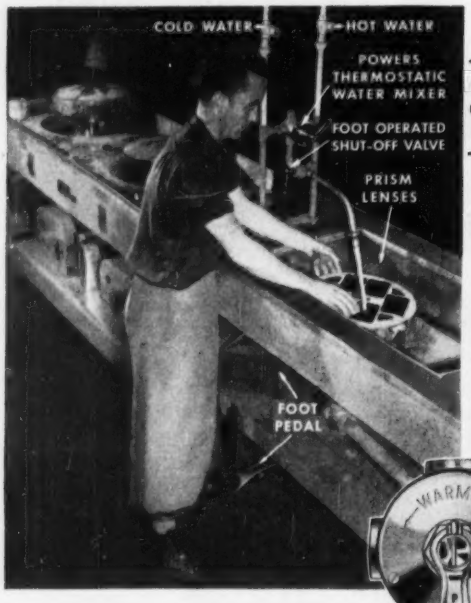


focused on POWERS Temperature Control

FAMOUS ARGUS C3 35 MM CAMERA

Precision Lenses for this and other Argus cameras, and projectors and optical components for complex optical instruments used in our nation's defense — are produced in Argus' modern optical plant.

—for better regulation of washing polished lens blocks



Worth an extra pair of hands

HERE ARE THE RESULTS

Combination of a POWERS Type H Thermostatic Water Mixer and a Bradley foot operated shut-off valve release both of worker's hands for lens washing. Instant shut off prevents waste of water. Accurate control of water temperature prevents damage to lens.

75 Powers Thermostatic Water Mixers are used in Argus' large completely modern optical plant. Row upon row of machines like those shown here polish lenses and prisms to a high degree of accuracy.

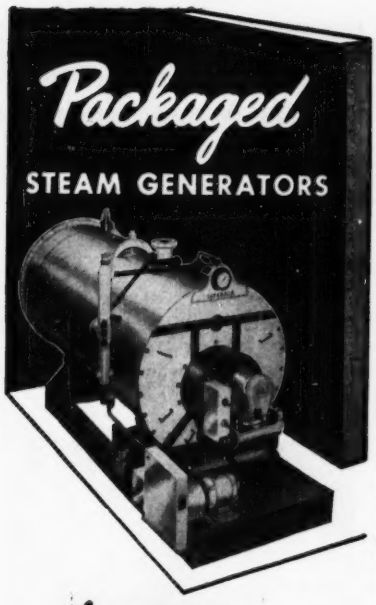
POWERS Control Saves Labor and Hot Water . . . *Also Helps Prevent Damage to Lenses*

Accurate temperature control of water used in washing lens blocks is very important. The double safety of a Powers thermostatic water mixer shown at left insures the most accurate control obtainable.

It automatically mixes hot and cold water and delivers a mixture at any temperature desired regardless of **pressure** or **temperature** changes in water supply lines. Failure of cold water instantly shuts off the delivery. Users often report accuracy of ± ½° F. Capacity 2 to 10 gpm @ 45 psi. Write for Bulletin 365. Larger Capacity Water Mixers available up to 1200 gpm @ 45 psi. Write for Catalog WC.

Check Your Control Problem with an Experienced POWERS Engineer. He will help you select the proper type of control for your requirements. Contact our nearest office or write us direct. (b68)

Established in 1891 • THE POWERS REGULATOR COMPANY • SKOKIE, ILL. • Offices in Over 50 Cities



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Economical, and highly efficient, **SUPERIOR Steam Generators** arrive at your plant ready to produce steam for process or heat. Completely factory assembled and tested, they are backed by undivided responsibility.

- Fully automatic burning oil or gas or both in combination.
- Mounted on rigid channel iron base, they require no special foundation.
- Built-in induced draft eliminates the need of an expensive chimney.
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- Battery installation provides extreme flexibility for varying steam demands.
- Special units for permanent outdoor installation.
- Fire-Tube models in 18 sizes from 20 to 600 b.h.p. for pressures up to 250 p.s.i. Write for catalog **622-F.**
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One-Stop Source For Corrosion-Resistant Cements, Coatings

PHILADELPHIA, PA. The Pennsylvania Salt Manufacturing Co. now offers industry a complete line of corrosion-resistant products, including resin, silicate, and sulphur cements, various coatings, and interliners.

The most recent addition to this group is new Pennsalt Furan Cement*—a basically different *furfural-ketone* resin cement. It provides advantages common to all furan-type cements (good stability, does not cause dermatitis), plus these six important points of superiority:

1. Actual 2-to-1 powder-solution ratio.
2. Increased acid resistance.
3. Increased alkali resistance.
4. Increased resistance to most solvents.
5. Easier handling characteristics.
6. Only 0.2% water content.

Pennsalt Furan Cement is available with a choice of 2 powders—Powder "C" (carbon) or Powder "S" (siliceous filler). It costs less to buy and use than common furan-type cements, with a 25-30% saving when you use Powder "S".

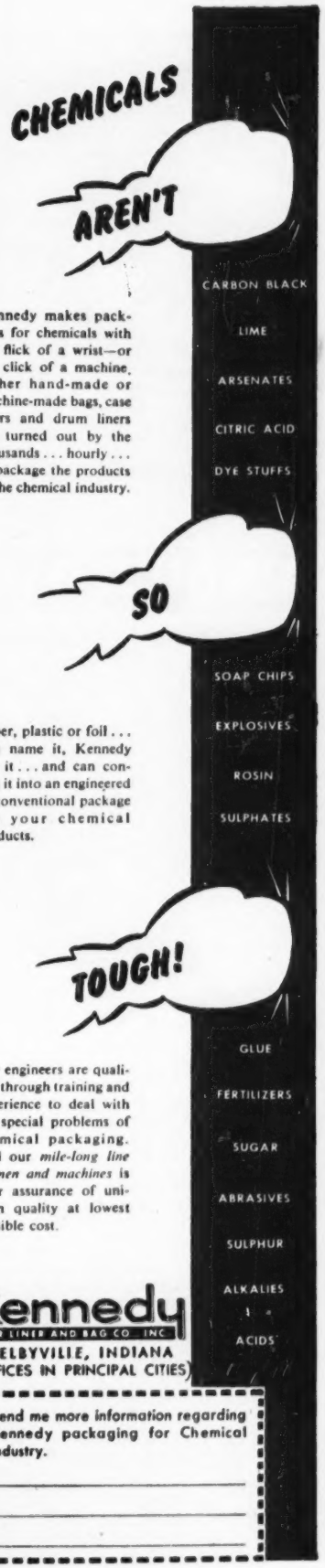
Among the many corrosion-resistant coatings Pennsalt offers are NeoCoat (based on liquid Neoprene) and its companion products. The NeoCoat System, designed to give high build per coat, has proved to be outstanding during more than three years' service in actual operating plants.

To help customers properly choose and use these products, Pennsalt offers the technical assistance of its "corrosioneering" specialists. Engineering drawings are also available for the construction of various components.

For specification sheets on any of these products, interested readers should write: Corrosion Engineering Dept., Pennsylvania Salt Manufacturing Co., 657 Widener Bldg., Philadelphia 7, Pa.

*A Furatone Product, mfd. under Pat. Nos. 2,461,510 & 2,600,764. Furatone is a trademark of Irvington Varnish and Insulator Division, Minnesota Mining and Mfg. Co.

(*Advertisement*)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Kennedy makes packages for chemicals with the flick of a wrist—or the click of a machine. Either hand-made or machine-made bags, case liners and drum liners are turned out by the thousands . . . hourly . . . to package the products of the chemical industry.
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SOAP CHIPS
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Paper, plastic or foil . . . you name it, Kennedy has it . . . and can convert it into an engineered or conventional package for your chemical products.
TOUGH!
GLUE
FERTILIZERS
SUGAR
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SULPHUR
ALKALIES
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Our engineers are qualified through training and experience to deal with the special problems of chemical packaging. And our *mile-long line of men and machines* is your assurance of uniform quality at lowest possible cost.
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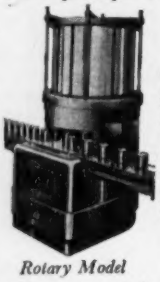
Send me more information regarding Kennedy packaging for Chemical industry.

VACUFLOW

POWDER FILLERS

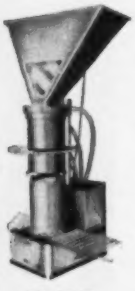
Cut Product Wastage. Vacuflow powder filling equipment operates on a principle of vacuum feeding, instead of pressure, to pack powder into a container.

Air is removed from the container to create a vacuum which draws a measured quantity of powder from the hopper. There is no problem with dust control, since the unique Vacuflow method simply does not involve air currents that cause dust.



Rotary Model

Semi-automatic models are available for filling containers ranging from the tiny talcum box up to and including 100 lb. paper bags and 200 lb. drums. Rotary models are available for automatic production of 5 lb. sizes or less at speed of 45 to 300 per minute.



Model E

Pneumatic is the one manufacturer in a position to furnish machines for making up complete production lines. Units are available for air cleaning, powder and liquid filling, capping and labeling a wide range of bottles, cans or jars.

PNEUMATIC SCALE CORP., LTD.
67 Newport Ave., Quincy 71, Mass.
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PNEUMATIC

SUPER HIGH PURITY WATER

by the trouble-free magic of ion exchange

No "~~[illegible]outs~~"
No "~~[illegible]odors~~"
No ~~[illegible]~~
No ~~[illegible]~~ or ~~steam~~ power

Penfield Mono-Column Demineralizer Model M-100. Purity of effluent: less than 2 ppm. Flow rate: 60-90 gph. Dimensions: 1½' x 2' x 7'. Features inspection window that allows easy inspection of crucial middle distribution system.

Penfield Mono-Column Demineralizer Model MA-1000. Purity of effluent: under 1 ppm. Flow rate: 1000-1200 gph. Dimensions: 2' x 5' x 5½'. Features automatic shut-off and signaling devices and fully automatic regeneration system.

Penfield Dual-Column Demineralizer Model UL-60. Purity of effluent: 5 to 10 ppm. Flow rate: 75-100 gph. Dimensions: 2' x 2' x 4½'. Features self-contained stainless steel control cabinet in which regenerant tanks are stored.

READY TO OPERATE ON ARRIVAL!

Available in a wide variety of mono-and multi-column models (flow rates from 10 to 10,000 gph), all Penfield Demineralizers come equipped with regenerant tanks and all necessary gauges, flow meter, conductivity meter, etc. On arrival at site, simply connect the completely "packaged" unit to service lines and start receiving super high purity Penfield demineralized water.

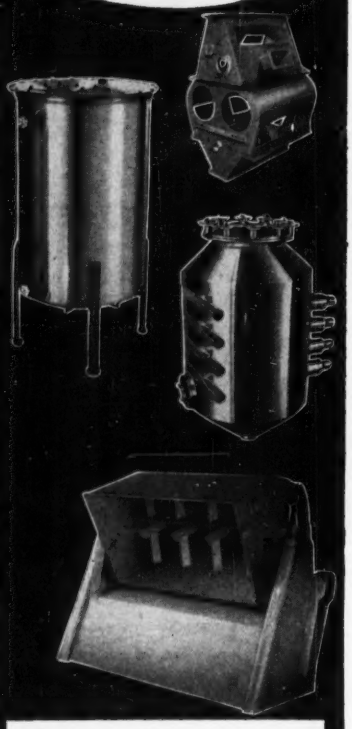
Any model Penfield Demineralizer may be secured with automatic shut-off and signaling devices and a fully automatic regeneration system. Special control systems for the automatic maintenance of the purity of storage tank water supplies also available.

Write for fully descriptive catalog.
PENFIELD M'FG. CO., INC.
19 High School Ave., Meriden, Conn.
Filters · Softeners · Degasifiers · Demineralizers

PENFIELD "PLANNED PURITY" PAYS!

LITTLEFORD
STAINLESS STEEL
AND ALUMINUM
FABRICATED PRODUCTS
FOR THE

CHEMICAL INDUSTRY



Fabricating Tanks, Bins, Vats, Troughs, Carts, or Special Units, Littleford offers its years of experience in producing quality products at low cost. Experience in shearing, bending, forming, and welding Stainless Steel, Aluminum, Nickel, Monel or other Alloy Metals plus skilled craftsmen is assurance of the finest workmanship. Littleford's modern facilities to produce non-corrosive units afford an unprecedented standard of dependability. If you need a product fabricated with accuracy, whether large or small, send blueprints to Littleford. See for yourself how it can be done the modern low-cost way.

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The Industries We Serve— **TEXTILES**

That's a rainbow she's sitting on!

Perching on a pile of bituminous isn't exactly a normal situation for this pert lass. But can you think of a better way to point up the close kinship between her pretty dress and *coal?* Especially if its color came from a brilliant Pittsburgh Dyestuff . . . and its new "miracle" fiber from a Pittsburgh Coal Chemical.

Transforming a pile of coal into a rainbow of finished dyestuffs, *all within one integrated plant,* is part of one of industry's most unique manufacturing operations. It allows precise quality control at *every* step of production. And in dyemaking, that assures some very important benefits to our customers in the nation's great textile industry: Truer, faster shades and reliable, continuing supplies, for example.

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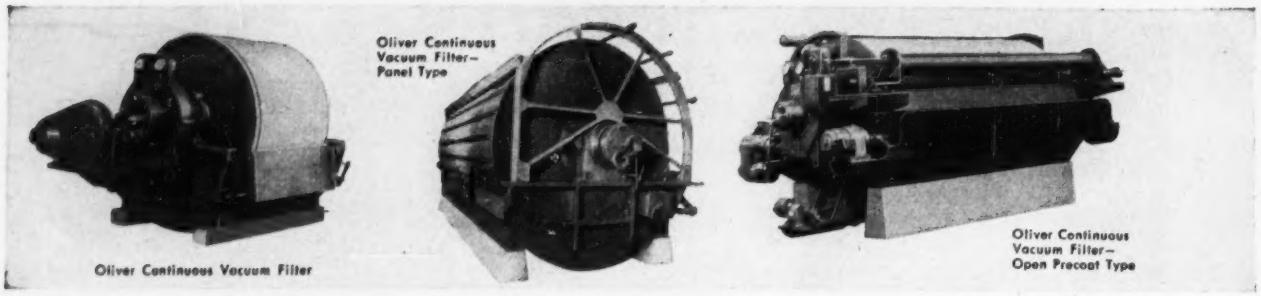


Oliver Continuous Vacuum Filter

Oliver Continuous Vacuum Filter—Panel Type

Oliver Continuous Vacuum Filter—Open Precoat Type

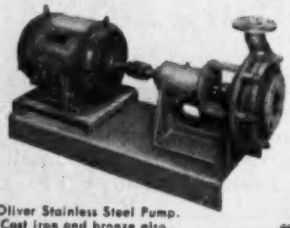
WHY OUF FILTER TYPE SELECTIVITY PLUS OUF FILTRATION EXPERIENCE WILL SERVE

Over the years, Oliver United Design Engineers have spent thousands of hours developing and proving out many different types of filters in the three basic principles of filtration: continuous vacuum, continuous pressure, and batch pressure.

Why go to all this trouble? Why not just one filter in a range of sizes or at most, one filter for each principle?

It's because long ago wide contact with filtration problems all over the world indicated that no one filter type could possibly serve *all* requirements well. That same condition holds today. In the countless varieties of materials being filtered, seldom are two exactly alike. Filtration characteristics change with the size, shape and specific gravity of solids, with the pH of the solution, with its viscosity, with the dilution, with the temperature. Every change in physical, chemical, hydraulic, even ionic conditions changes the filtration characteristics.

A FEW WORDS ABOUT OUR PUMPS



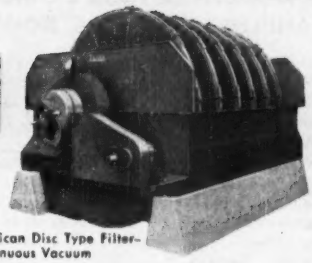
Oliver Stainless Steel Pump. (Cast iron and bronze also available) Bulletin 310-T.

Olivite Acid Handling Pump. Bulletin 308-R2.

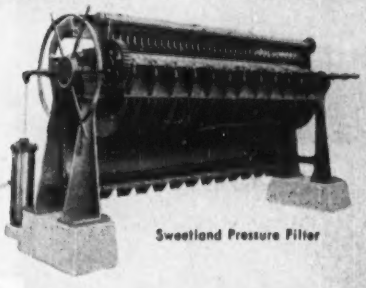
ODS Diaphragm Slurry Pump. Bulletin 309-R.

What's your pumping problem? Hot or cold chemical solution? Acid? Alkali? Slurry? In writing for Bulletins describing our pumps, tell us about your problem.

Oliver Horizontal Filter – Continuous Vacuum



American Disc Type Filter – Continuous Vacuum



Sweetland Pressure Filter

Kelly Pressure Filter

unmatched anywhere

likewise unmatched anywhere

YOU BEST

The real meaning and value of this broad Oliver United service will be clear to you. Wouldn't you be better off in selecting, not from one or two or three different types but from nearly a score of types to find the one best for *your* problem?

This is the type selectivity Oliver United has to offer, unmatched anywhere.

Wouldn't you also want the recommendations of engineers whose experience beginning in 1907 is as broad as it is long . . . engineers who can focus on your problem the experience developed by serving *every* industry on thousands of materials all over the world . . . engineers who have complete field and laboratory testing facilities with a variety of small operable filter models at their disposal?

This is the filtration experience and service Oliver United has to offer, likewise *unmatched anywhere*.

Kelly Pressure Filter – Sulphur Type

Oliver Continuous Pressure Filter – Precoat Type

Oliver Pressure Filter

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Install Bowser XACTO, the meter that's changing chemical processing habits. Wherever accurate measurement is essential to assure product uniformity ... XACTO will do the job.

XACTOS speed production, too. For batching just set them to deliver predetermined quantities ... and they will shut themselves off. For continuous blending of two or more liquids use the Xacto Blending System.

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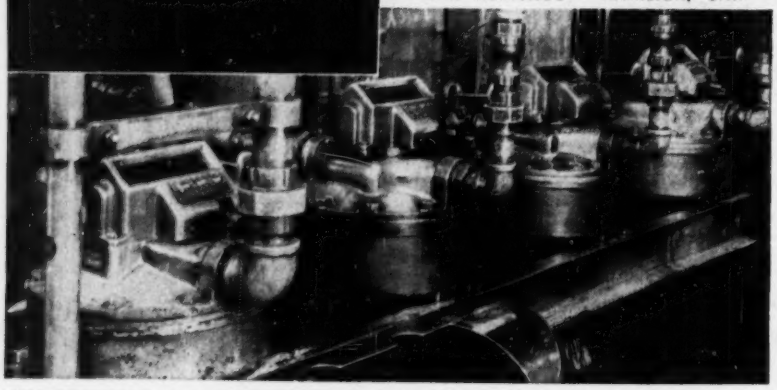
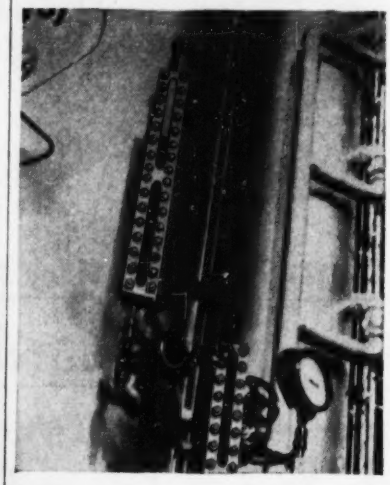


BLACK WHITE VISIBILITY



JERGUSON Series #5 Reflex Gages Give you up to 19¼" of Clear Visibility

THE sharp black-white contrast of the liquid level against the empty space above, in Jerguson Series #5 Reflex Gages, makes possible highly accurate liquid level readings even where lighting is poor.

To give you extra long service, the gages are corrosion resistant; and the glasses are specially treated with Jerguson Anti-Fouling Compound to give clearest visibility over a long period.

Series #5 Low Pressure Reflex Gages are available in sections to give you any desired total gage length. Materials used are selected to conform to or exceed the rigid requirements of A.I.S.I., A.S.T.M., and/or A.P.I.-A.S.M.E. specifications.

You can depend on Jerguson Gages. Write today for full information on Series #5 Gages, or for help on any gage problem.

JERGUSON

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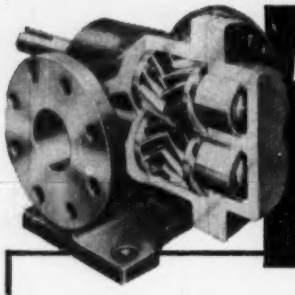


Low Cost Gear Pump for Heavy Duty

32 SSU to 250,000 SSU; 1-500 GPM; 300 PSI for continuous duty, 500 PSI for intermittent service

- Hydraulically balanced axially
- Only 2 castings
- Only 2 moving parts
- Precision manufactured rotors
- Heavy duty roller bearings
- Shafts hardened & ground
- Only one stuffing box (under suction pressure)

Use the Sier-Bath "Hydrex" in place of pumps costing much more ... for handling chemical solutions, fuel oils, lube oils, hydraulic liquids, etc.

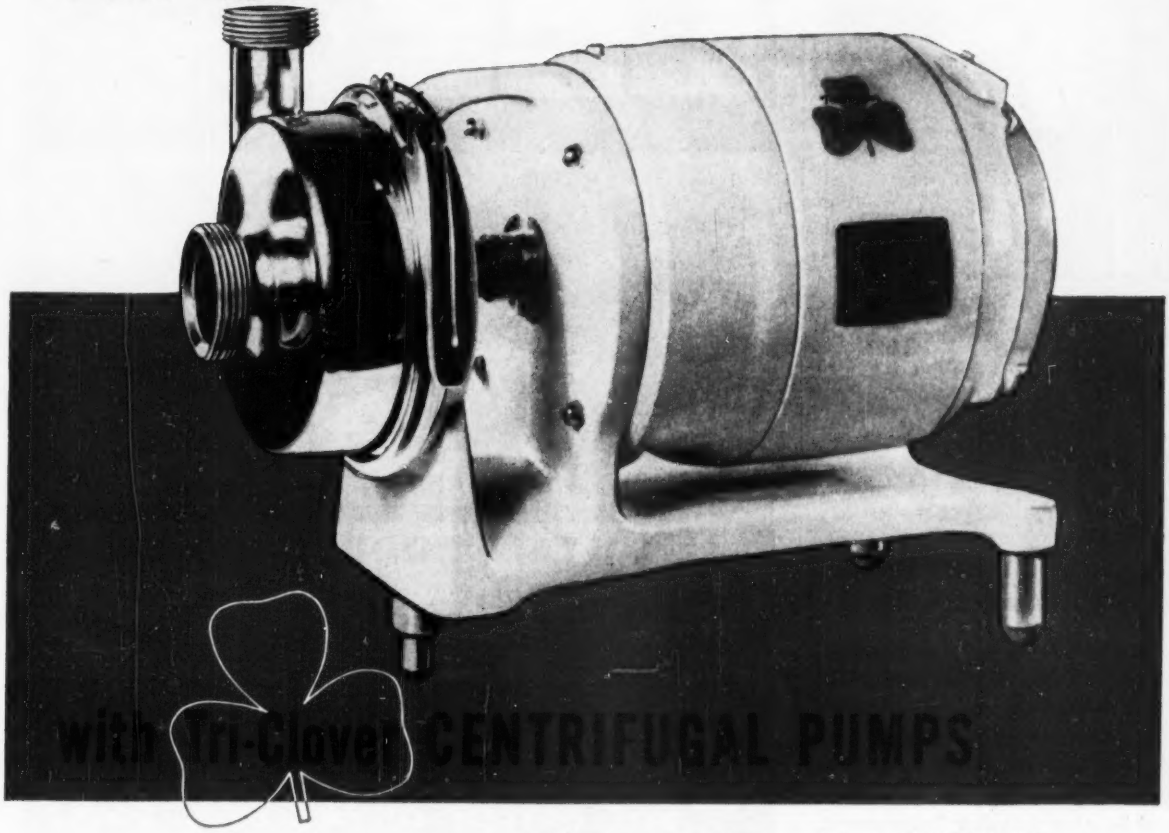
Simplicity is the key to the high capacity, low maintenance cost and long life of the "Hydrex." It made possible larger rotors and bearings ... shorter, heavier shafts ... quicker assembly and disassembly ... all in a *low cost* unit. For easier piping and aligning, all machined surfaces are ground, and connections are standard.

Call your Sier-Bath Pump Representative ... or send for "Hydrex Reply Sheet." Reverse side can be filled in for prompt quotation. *Sier-Bath Gear & Pump Co., Inc., 9259 Hudson Blvd., North Bergen, N. J.*

Sier-Bath "HYDREX" Pumps

Sier-Bath "Gearex" & Screw Pumps for higher capacities and pressures ... also mfrs. of Precision Gears and Flexible Gear Couplings. Founded 1905 ... Member A.G.M.A.

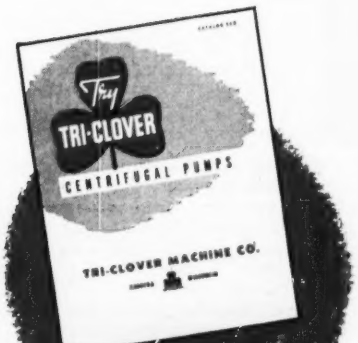
You Get More for Your Money



. . . and here are some of the reasons why: (1) *Wide choice of seal types, tested and proved for specific applications;* (2) *Design and manufacture that actually exceeds 3A sanitary standards;* (3) *Streamline heads—faster assembly and disassembly—easy to clean;* (4) *Patented impeller—higher efficiency—minimizes foaming action;* (5) *Pump heads can be turned full 360 degrees—simplifies installation.*

These are just a few of the advantages you get when you specify TRI-CLOVER Centrifugal Pumps. These modern, high efficiency units are backed by years of specialized experience, and are available in a full line of sanitary and industrial types to meet practically every corrosion-resistant pump requirement.

Let our experienced engineering staff help in solving your pumping problems.



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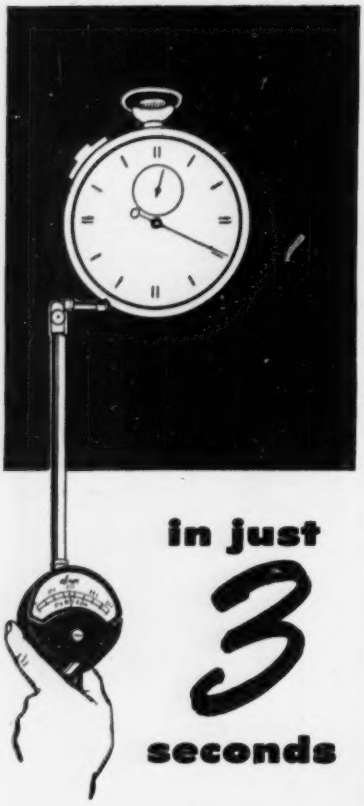

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. . . you can read any surface temperature in your plant . . . accurately and easily . . . with the Alnor Portable Pyrocon.

Compact in size, complete in precision design and workmanship, this rugged instrument assures the highest standards of speed, accuracy and dependability. You can take temperature readings on materials in process, the finished product or the heated equipment itself—in as few as 3 seconds!

Alnor Portable Pyrocons come in scale ranges to 2000° F., with thermocouples for every application. You'll find full details on the Pyrocon exactly suited to your operations in Bulletin 4257. Send for your copy now. Write: Illinois Testing Laboratories, Inc., Room 559, 420 North LaSalle Street, Chicago 10, Illinois.

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FOR EVERY PROCESSING NEED

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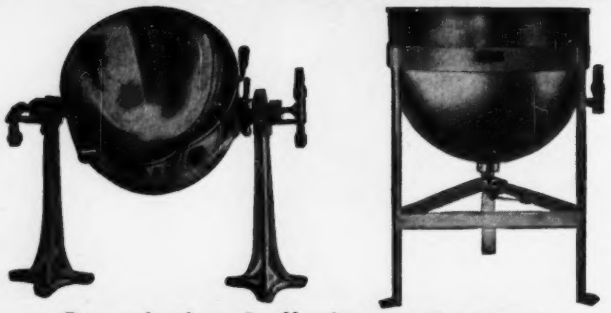

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...but which is the best buy?

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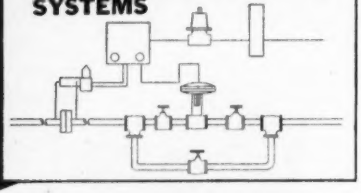

1. Simple—self-contained, direct-acting.
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3. Fast—pressure changes directly linked to valve. Valve acts almost instantly.
4. Installation—2 simple pipe connections.
5. No overshooting—no undershooting—no "hunting" for proper setting. Finds set point immediately.

1. Complex—multiple valves, pipes, wiring, balances.
2. Costly maintenance—many parts and connections to inspect, adjust.
3. Slower action—pressure changes must be transmitted to valve. Result: time lag.
4. Installation—complicated, requiring many man hours.
5. Pneumatic lag—elastic linkage between measurement and control requires careful and detailed adjustment. Takes time to find set point.

Now—which is your BEST buy?

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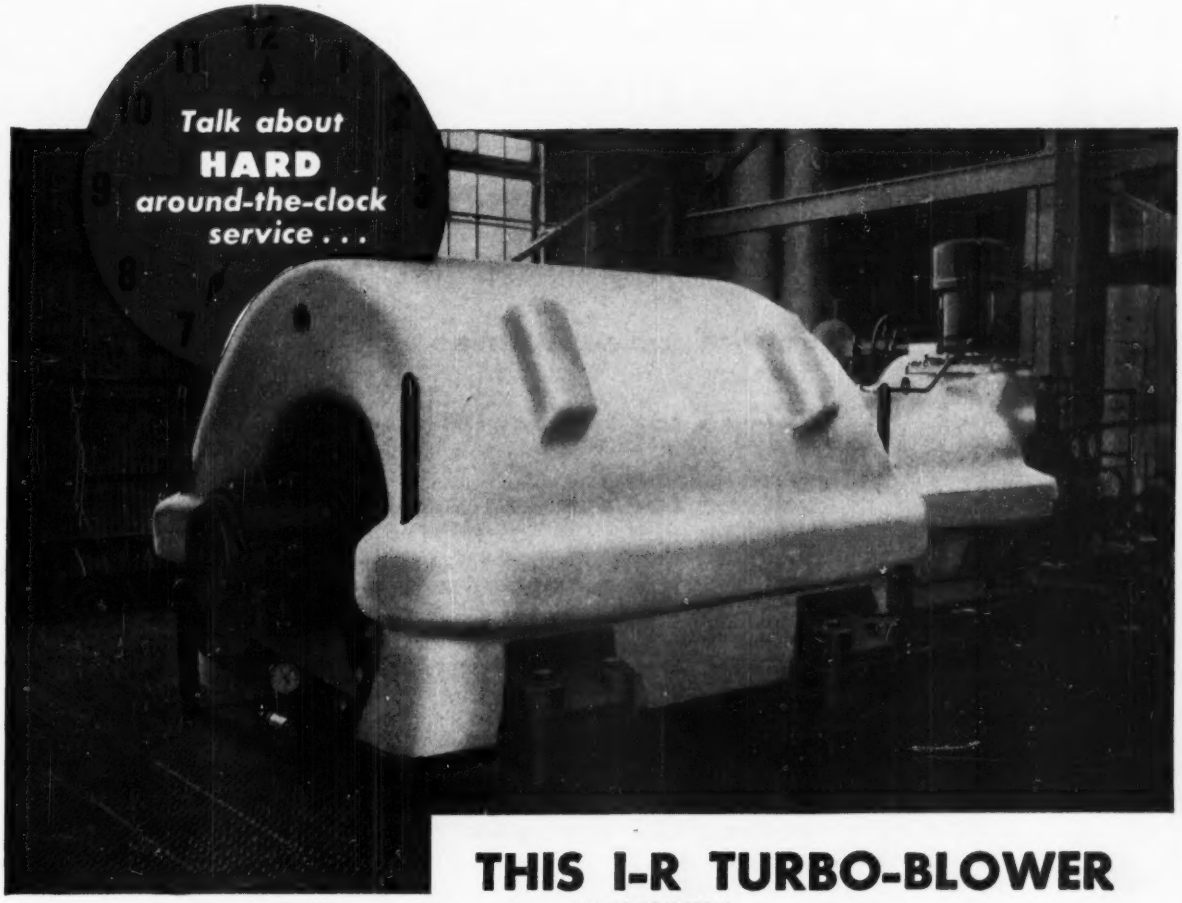

THIS I-R TURBO-BLOWER COMPRESSES 648°F FLUE GAS

at American Potash and Chemical Corp.

The Ingersoll-Rand Turbo-Blower at the Trona, California plant of American Potash and Chemical Corporation compresses 20,000 cfm of flue gas to 13 psig. Since the temperature of the gas, which is taken from the oil-burning boilers, is 648° F. at the blower discharge, the unit is heavily lagged. The blower and its 1265 hp turbine operate continuously 24 hours a day. *There is no spare.*

After being compressed the flue gas (13-14% carbon dioxide) is bubbled through carbonating towers containing brine from nearby Searles Lake. The precipitate formed is further processed by thickening, filtering, drying and calcining into soda ash.

In the process industries, and wherever large volumes of air or gas must be compressed to moderate pressures, over 3,000,000 horsepower of I-R Turbo-Blowers are repeatedly proving their economy and dependability in delivering oil-free and pulsation-free air or gas.

Ingersoll-Rand Turbo-Blowers are designed and built so as to guard against costly interruptions that could shut down your entire plant. For example, one I-R 11,000 hp Turbo-Blower was opened for inspection after six war-time years of continuous service. It was in good condition. While we don't approve of neglecting periodic inspection and maintenance, we are proud that the original low power consumption of this unit was not affected . . . that there was no costly maintenance . . . and that production was not interrupted.

I-R manufactures Turbo-Blowers in all sizes: to 20,000 hp, to 150,000 cfm, to 110 psig and higher. Therefore, whatever your blower application, Ingersoll-Rand can design and supply the Turbo-Blower that's right for the job—a blower you can depend on for constant delivery of air or gas at the lowest possible cost.

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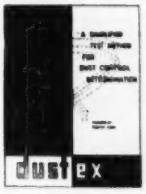

Effective dust control can eliminate all of these troublesome conditions. To get the facts on how you can determine the scope of your dust problem and the most efficient equipment for effective control, write for our new manual, "A Simplified Test Method for Dust Control Determination."

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These actuators are for power operation of gate, plug diaphragm, and other line valves. They are pneumatically or hydraulically operated for direct or remote control. Designed as package units, they are mounted directly on the valves without need of special manifolds or outside supports. Easily, quickly and rigidly installed on new valves or on valves in service . . . *Prompt delivery.*

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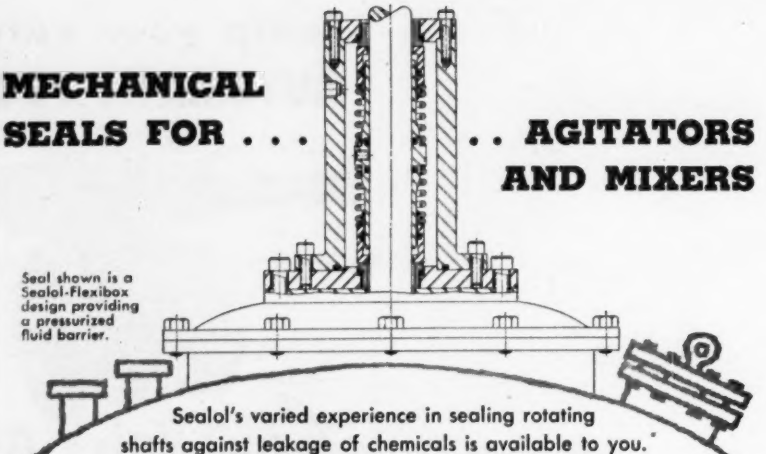

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Sealol's varied experience in sealing rotating shafts against leakage of chemicals is available to you. Does your shaft sealing problem come within these limits?

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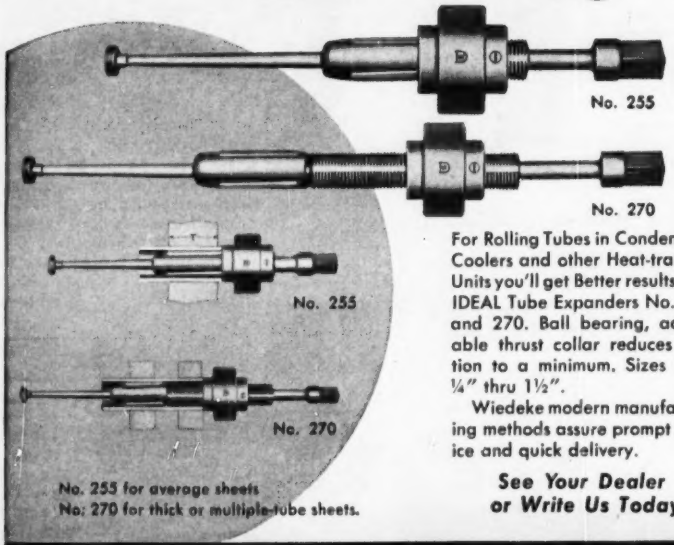

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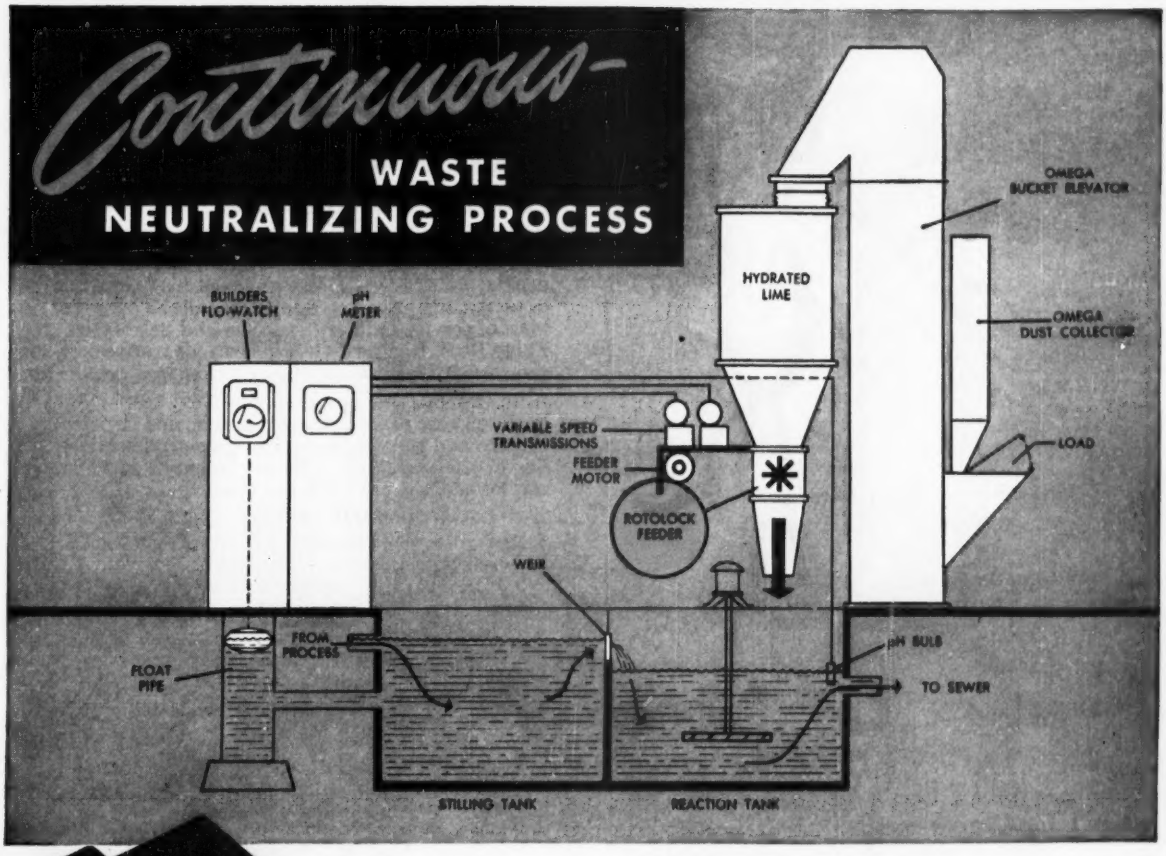

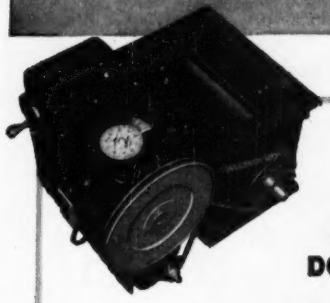

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Omega Rotolock — a rotating vane feeder — feeds hydrated lime into the reaction tank in response to the flow of acid waste (measured by a Builders Flo-Watch Instrument) and to the degree of neutralization (measured by a pH meter).

The Rotolock is a volumetric feeder of simple design and rugged construction, easily adapted to installations requiring proportional pacing by auxiliary meters. The Feeder, powered by a 1/4 HP motor, has a 100 to 1 feed range. Two models of Omega Rotolock Feeders are available, covering the complete range of feeds from 7.2 to 300 cu. ft. per hr.

Here's how Omega helped a customer's engineer solve a waste treatment problem for one of the nation's leading manufacturers of electrical and electronic equipment. This acid waste neutralizing "equipment package" comprises feeding, controlling, and metering units required for continuous, accurate operation . . . Omega bucket elevator, dust collector, storage hopper, Rotolock Feeder, and Builders Instruments and Control Panel. Performance of this "package" under actual job conditions has proven again that it pays to take advantage of Omega's engineering and manufacturing experience, when you need continuous proportioning equipment.

Hundreds of today's processing and production problems are being solved by Omega "packages" — for waste treatment, for proportioning two or more solids, for proportioning liquids and solids. Our engineers can help you —

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Our process problem involves:
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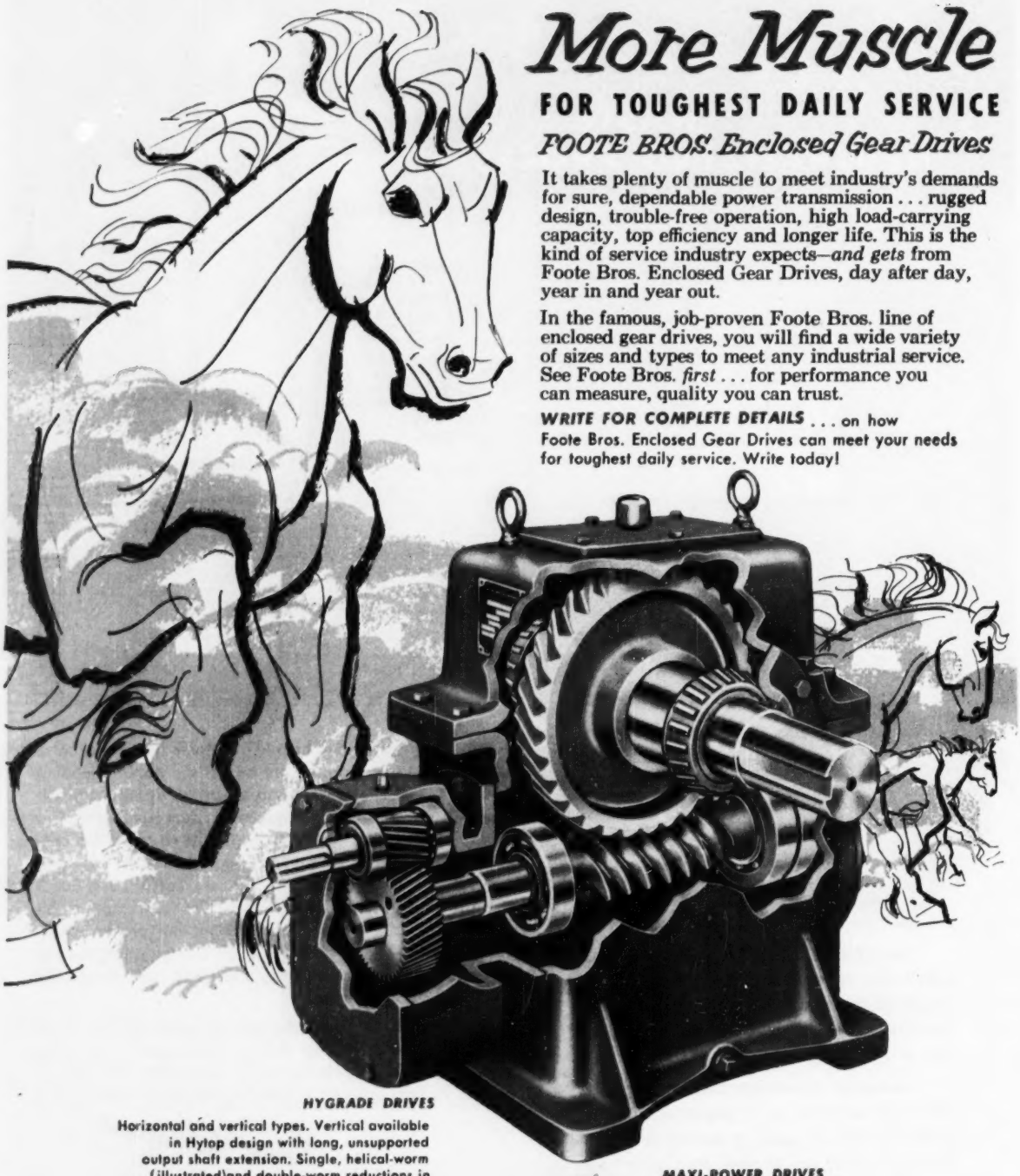

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Horizontal and vertical types. Vertical available in Hytop design with long, unsupported output shaft extension. Single, helical-worm (illustrated)and double-worm reductions in ratios up to 4108 to 1; capacities up to 260 h.p.

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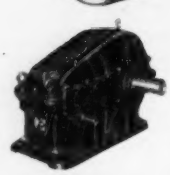

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Compact housings, specialized heat-treatment for gearing and improved accuracy of gear tooth generation mean longer, trouble-free performance. Ratios up to 360 to 1; capacities up to 1550 h.p.

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Incorporate higher capacity, space saving, longer life *Duti-Rated Lifetime Gears*. Available in double and triple reductions with ratios from 5 to 1, up to 238 to 1; capacity range from 1 up to 200 h.p.

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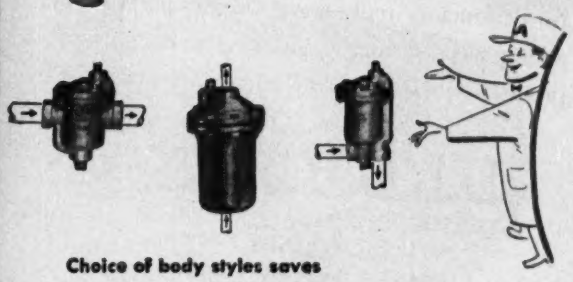
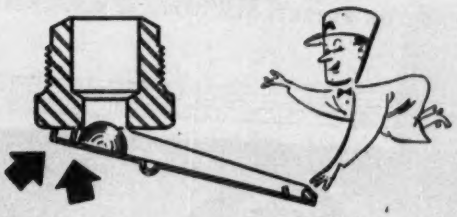
How Armstrong Traps Save you Money



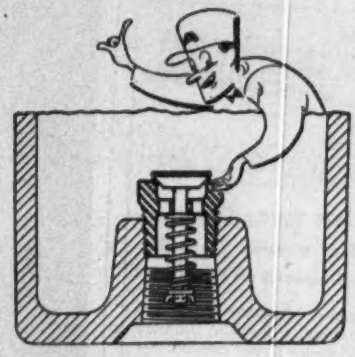
Choice of body styles saves money on installation costs.

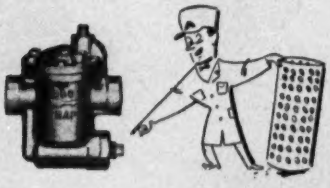
Hardened, ground and lapped valve and seat; stainless steel mechanism resists wear and corrosion—saves money on maintenance.



Two phase leverage means higher capacity in a smaller trap. Armstrong traps have optimum relation between leverage, valve travel, bucket weight, capacity and overall size.

This internal check valve saves labor and fittings required to install regular check valve.





This trap with built-in strainer costs less than separate trap and strainer—requires less labor and fittings to install.

Get the full facts on money-saving Armstrong traps. Send for free Catalog J. Clip and mail coupon today.

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#4 of a Series
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The Snell Spray Dryer, with its high overall operating efficiencies, low maintenance costs, and automatic control, reduces process time and high operating cost, with minimum capital investment.

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FLUOR *is building*

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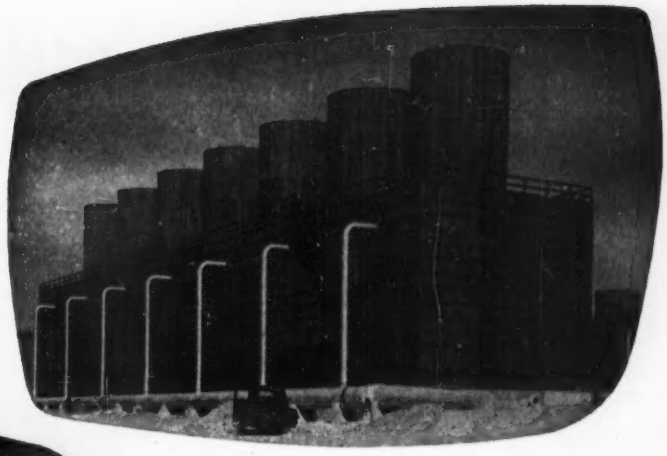
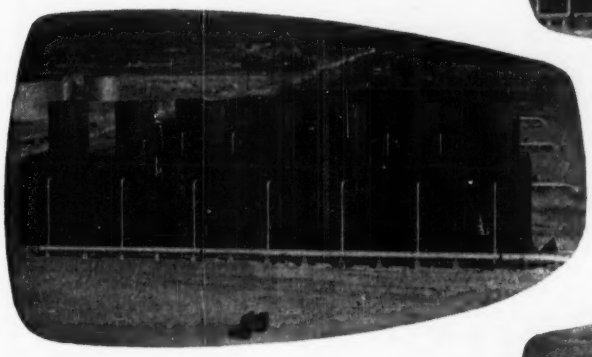
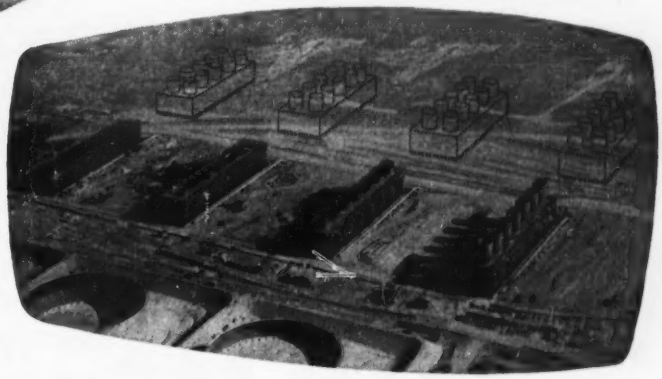




These Fluor Counterflo Cooling Towers are now being erected in the San Fernando Valley at the site of the new 512,000 KW steam-electric generating plant for the Department of Water and Power, City of Los Angeles. They comprise the largest initial cooling water circulating system utilizing cooling towers ever built.



The power plant itself is the largest initial installation inland and is being constructed in two sections. The first section consists of two units of 100,000 KW each, the second section of two units of 156,000 KW each. The four Fluor towers shown here (28 cells) in progressive stages of erection, are designed at 36,000 g.p.m. each, with a maximum of 42,000 g.p.m. They will service the first section of the plant. Design cooling range is 14° F with water entering at a temperature of 95° F and leaving at 81° F. The design wet bulb temperature is 70° F. Heat load is 1 billion B.t.u./Hr. for the first four towers.

Each cooling tower is 250 ft. long, 42 ft. wide and 37.5 ft. high to the fan deck. Twenty-foot, four-bladed fans are driven by 40 H.P. motors. Each fan moves 436,000 CFM. Capacity rating is 144,000 g.p.m. through a low pressure water distributing system. A distinctive feature of these towers is the Fluor-designed redwood stack standing 30 ft. high to minimize recirculation at peak load conditions.

Ground has been broken for the erection of four additional Fluor towers to serve the second section of the plant. Each tower will consist of 5 double-cells for a total of 40, with water circulation of 136,800 g.p.m. Design duty: inlet temperature 101° F, outlet 80° F, wet bulb 70° F. Heat load is 1,440,000,000 B.t.u./Hr. Dimension of these towers: 180 ft. long, 66 ft. wide, 45 ft. high to fan decks. Fans (18 ft.) will be driven by 40 HP motors and each will move approximately 350,000 CFM.

In addition, an auxiliary system (the bearing cooling water) employs a 4-cell Fluor Tower with a heat load of 40 million B.t.u./Hr.

When completed, total cooling water circulation will exceed 280,000 g.p.m. and *will circulate over 240 miles of condenser copper tubing.* Total heat load will approach 2½ billion B.t.u./Hr. The big jobs can be entrusted to Fluor, a firm with 33 years experience in the design and manufacture of cooling towers for every type of service. For complete details on Fluor Cooling Towers, write for the new illustrated bulletin, "Cooling Water for Industry."

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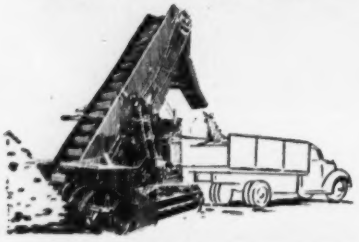

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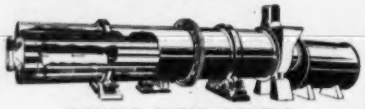

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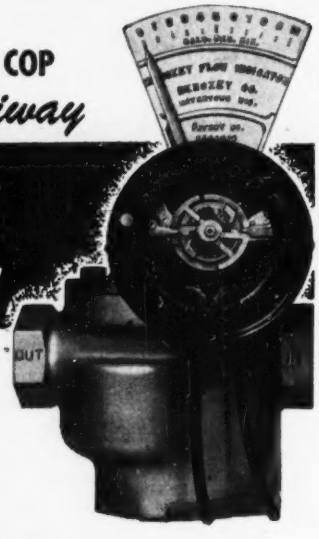

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Easy to set on face of switch — unaffected by dust, dirt or corrosion — no pitting or sticking.

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CHEMICAL PROCESS NEWS

PUBLISHED BY CHEMICAL PROCESS DIVISION, THE M. W. KELLOGG COMPANY JUNE 1954

NOTES ON

CUMENE

Cumene jumped into prominence during the last war when it was needed in large quantities for its anti-knock properties in aviation gasoline. More recently, renewed interest has developed in the chemical as a starting point in the manufacture of phenol.

***

To supply the sudden wartime demand for cumene, Kellogg designed and built four plants which were outstanding producers. In addition to this and subsequent post-war experience, Kellogg is currently building another cumene plant for a U. S. chemicals manufacturer as part of complete facilities for producing phenol.

***

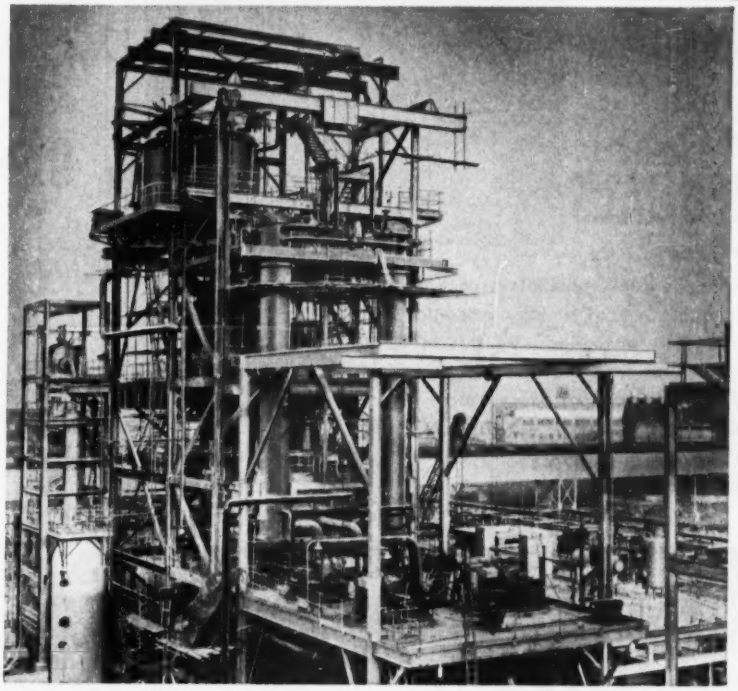
Heart of Kellogg's cumene process is a copper pyrophosphate catalyst developed in Kellogg's Jersey City, N. J. laboratory. Unique to the Kellogg process, and utilized in all of the plants the Company has built and is now building this catalyst gives the process two of its most important points of superiority —higher yields and a higher purity.

***

Copper pyrophosphate is extremely selective in the propylene-benzene reaction. Since it does not alkylate ethylene if present in the feed, high purity cumene required for phenol production can be obtained without removing ethylene from the feed or ethyl benzene from the final product, one of which steps would otherwise be required.

***

As an illustration of yield advantages, over-all conversion of benzene to cumene of other processes are described as falling in the range of 90 to 93%, based on benzene. By contrast, commercial data from Kellogg-built plants indicate yields ranging from 95 to 97% when copper pyrophosphate is employed.



Lower Operating Costs, Better Yields In Fluid Phthalic Process

Two phthalic anhydride plants currently under construction in Europe highlight not only the growing importance of this chemical abroad, but also the economic attractiveness of Kellogg's Fluid process for manufacturing it.

One of the two plants which is shown in the photo above is nearing completion in England under the supervision of the Kellogg International Corporation. The other is being built for a major chemical manufacturer on the Continent. When completed, they will have a combined yearly production of more than 40 million pounds of phthalic anhydride. In both cases, the product is obtained by oxidizing naphthalene in the presence of a fluidized solid catalyst.

Kellogg's Fluid process offers a number of distinct advantages over conventional processes with fixed beds. The Fluid catalyst principle makes for improved temperature control and results in optimum operating conditions. The efficiency obtained allows the use of less air—in some cases as much as 50% less—and better heat recovery.

In addition, yields are up to 5–10% higher; the product is of greater purity: and large Fluid plants can be operated with no more personnel than are required for fixed bed units of considerably smaller capacity.

For further information, technical data, etc., relating to chemical or petrochemical processing, write

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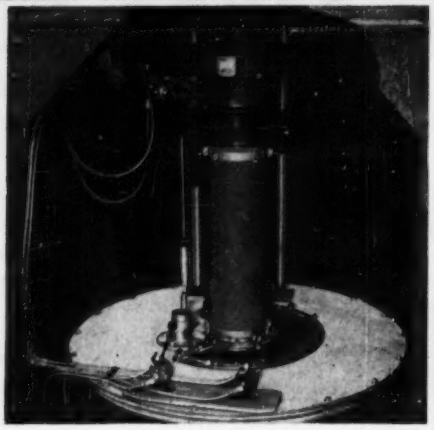

The latest Fletcher development in its line of modern high-speed centrifugals is the use of pneumatic controls to greatly ease and simplify unloading operation. By this means the back-breaking and fatiguing hand cranking operation is eliminated, and the operator's efficiency is materially increased. The scraper is at all times under complete control.

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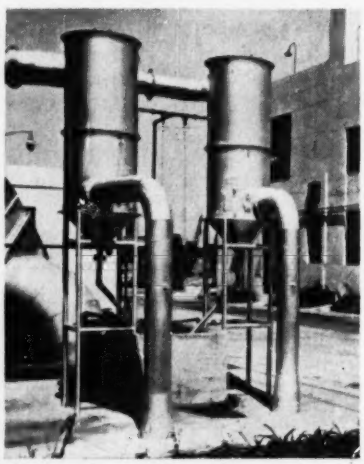
The counterflow action allows air, gas or vapors to pass spirally upward through several stages at a velocity that impinges or condenses the contaminant against wetted surfaces, where they are flushed down and out the outlet cone in the liquid. The water or liquid enters the unit through a full-sized, non-clogging pipe opening so that heavy concentrations of slurry may be recirculated.

The intensive action of the air stream with the liquid curtains and spray patterns has proven very successful in the removal of soluble gases and acid gases. The liquid used varies according to type of material to be collected. Complex odors are removed by the addition of oxidizing agents in the recirculating liquid.



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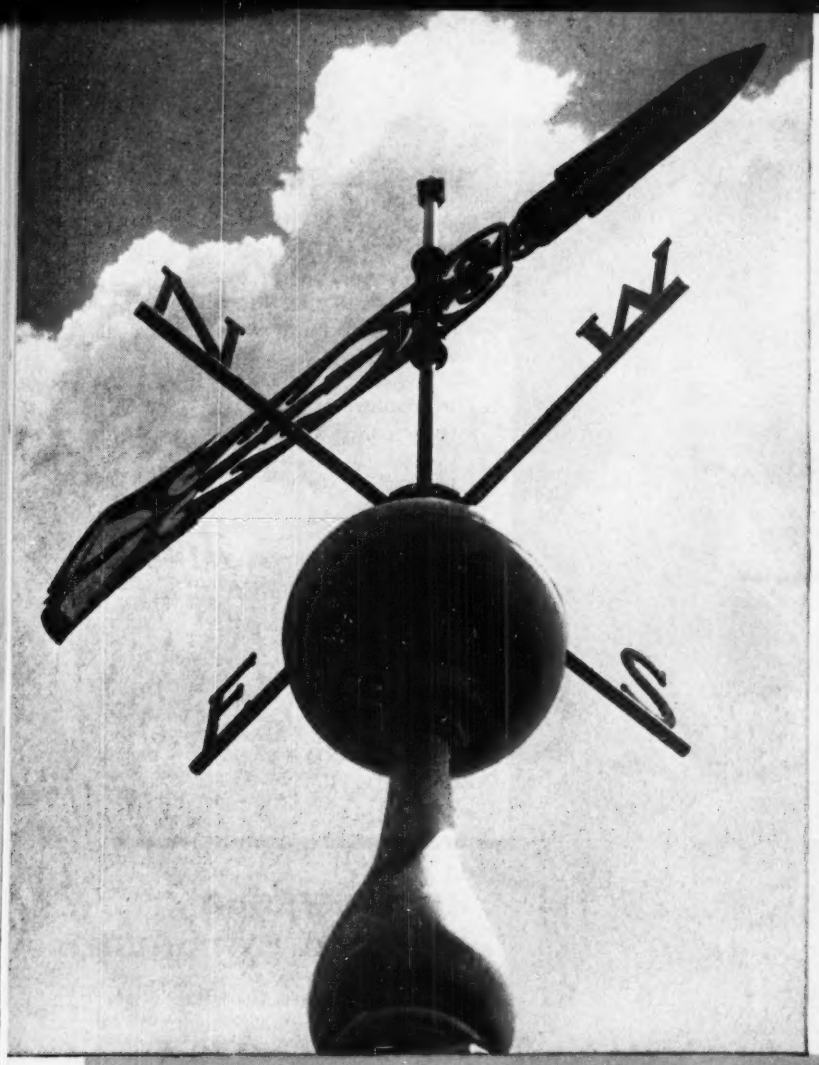

A Four-Way Selection

This photograph of a weather vane seems a good way to point out the fact that there are four different types of Midwest Welding Elbows (see below). These are more types than are manufactured by any other company. This greater selection is important to users of welded piping because it gives the engineer greater latitude in piping design and permits improvements and economies not otherwise possible in welded piping systems. For more information on this subject, ask for Catalog 54.

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Numerous advantages like:

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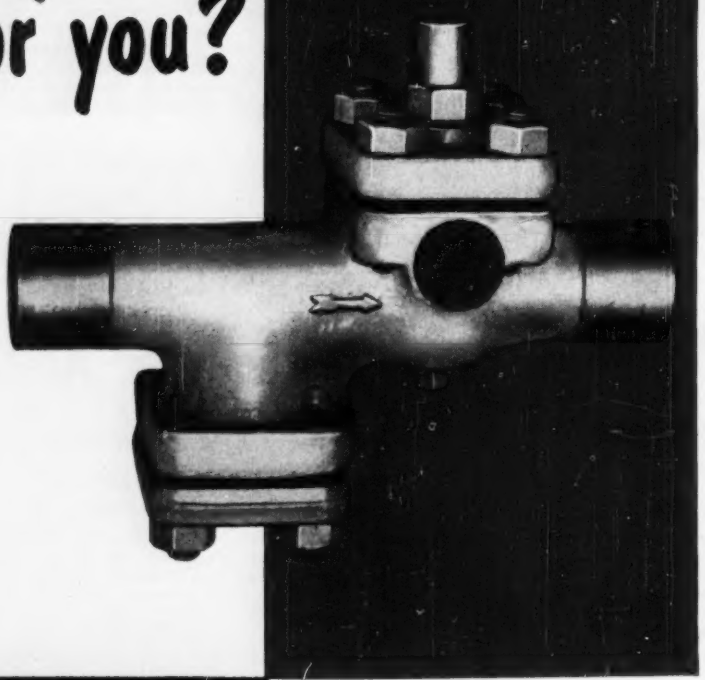
More than 900,000 used throughout industry.

Write for YARWAY Bulletin T-1740.



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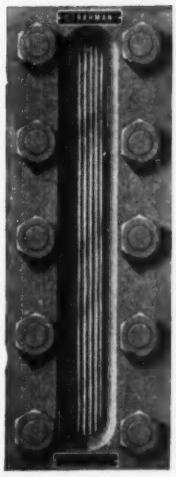

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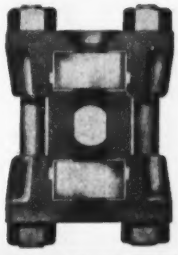

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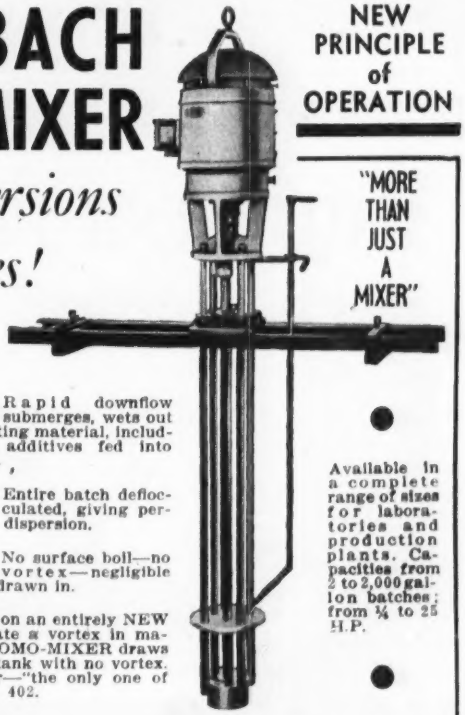

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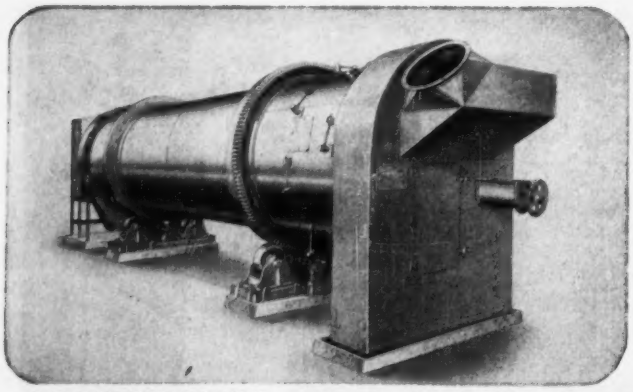

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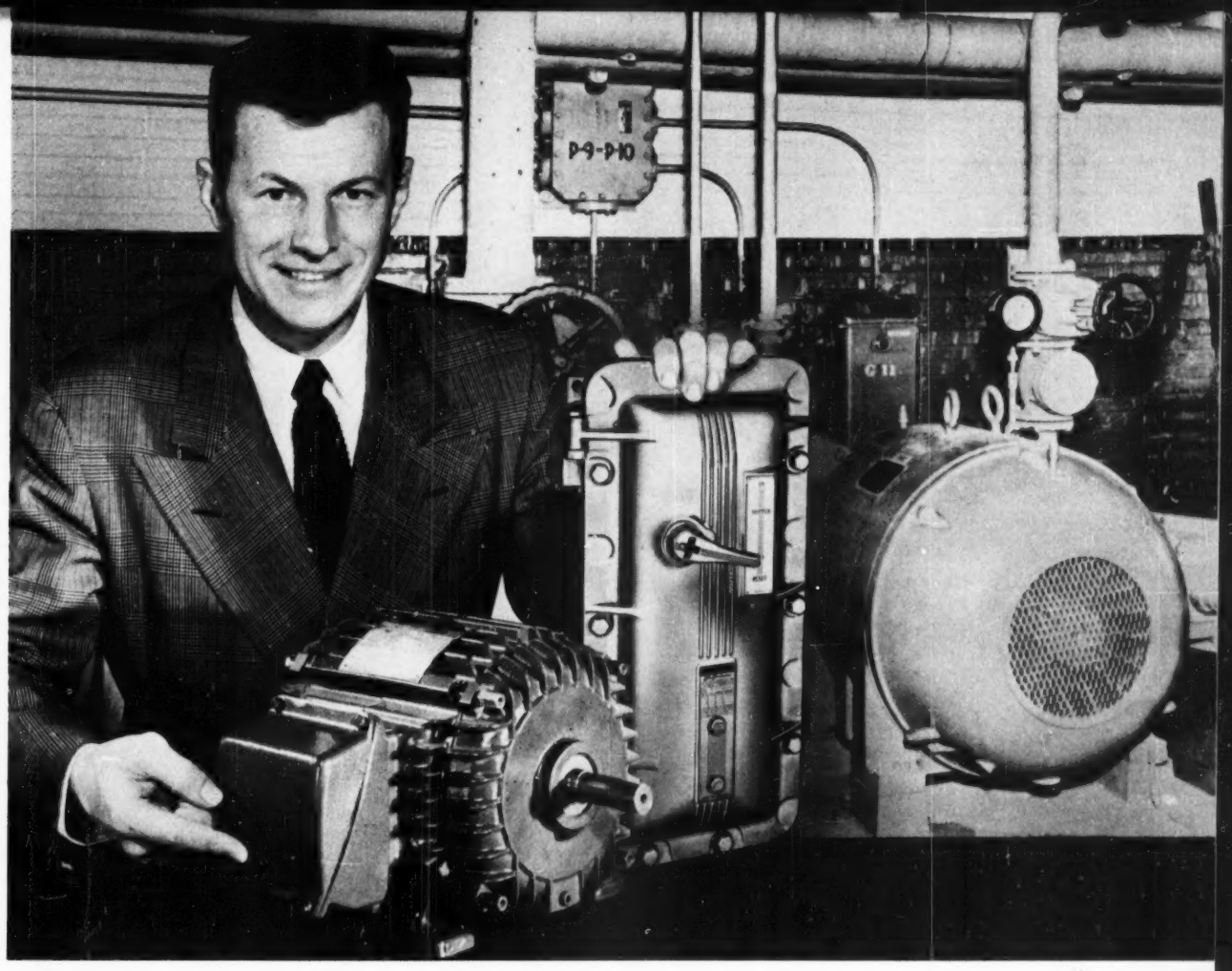

What you can do to attain round-the-clock production continuity

HERE ARE 4 WAYS WESTINGHOUSE POWER PARTNERS CAN HELP

Motion is basic to all chemical processing. Materials must be moved, mashed, blown, crushed and moved again. Keeping that motion uninterrupted is a mountainous task, but one that can be simplified by using time-proved Life-Line® motors, gearmotors and controls. Here's how:

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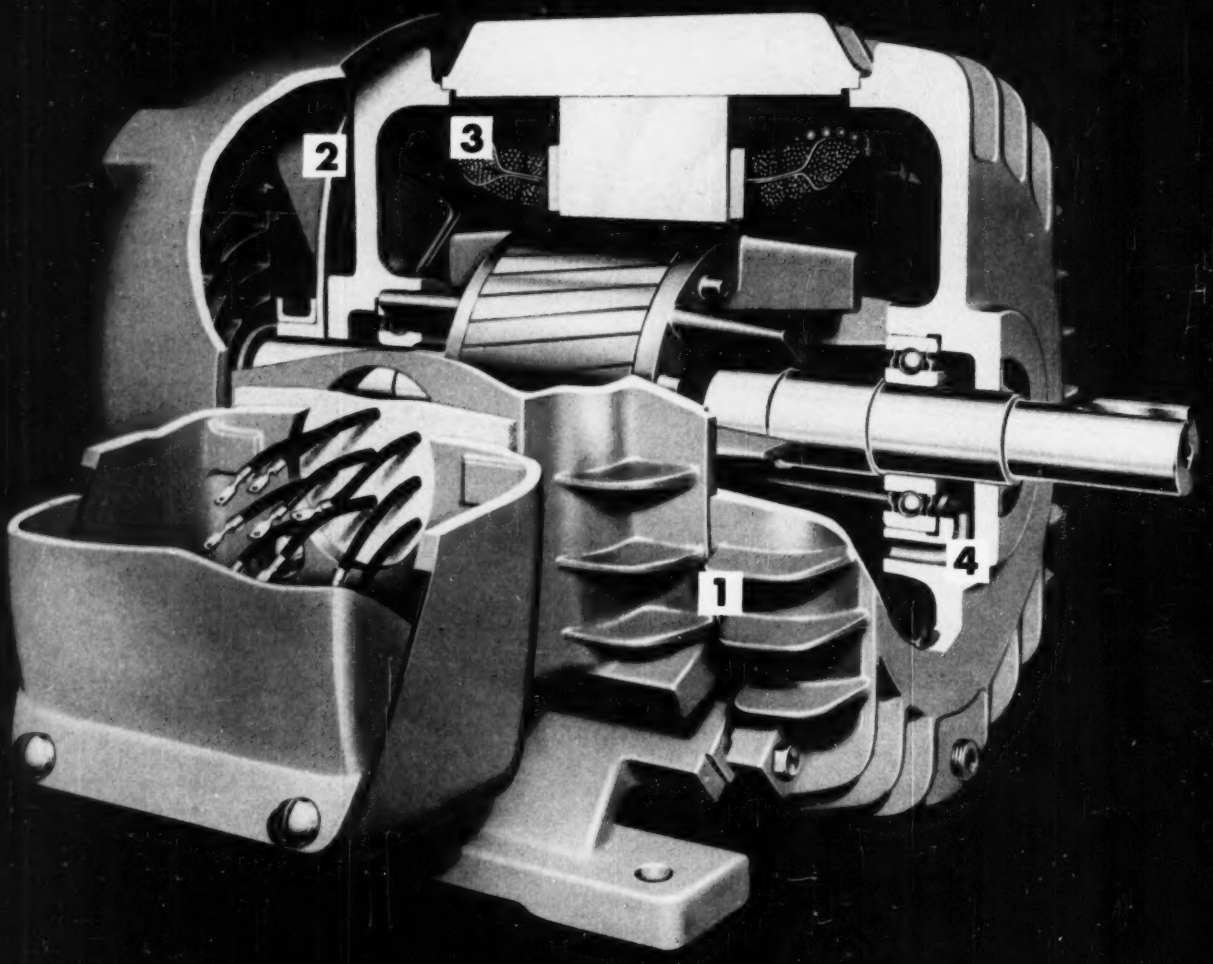
THE NEXT THREE PAGES DISCUSS OTHER REASONS WHY LIFE-LINE MOTORS AND CONTROLS CAN HELP YOUR PRODUCTION CONTINUITY.

MINIMIZE CORROSION...



1. CORROSION-PROOF CAST IRON FRAME AND BRACKETS The housing is the one element that is responsible for protection of the internal parts of the motor. The Life-Line housing provides three-way protection: (1) only fine-grained castings are used, (2) all wall sections are uniformly thick, and (3) all fits are accurate and sealed.

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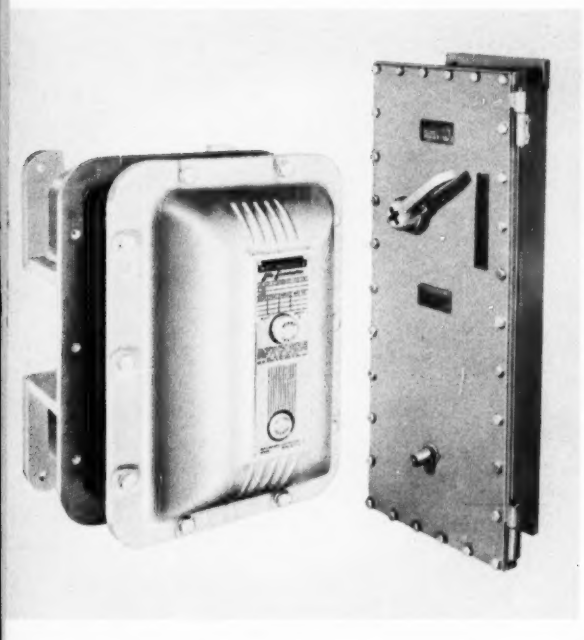
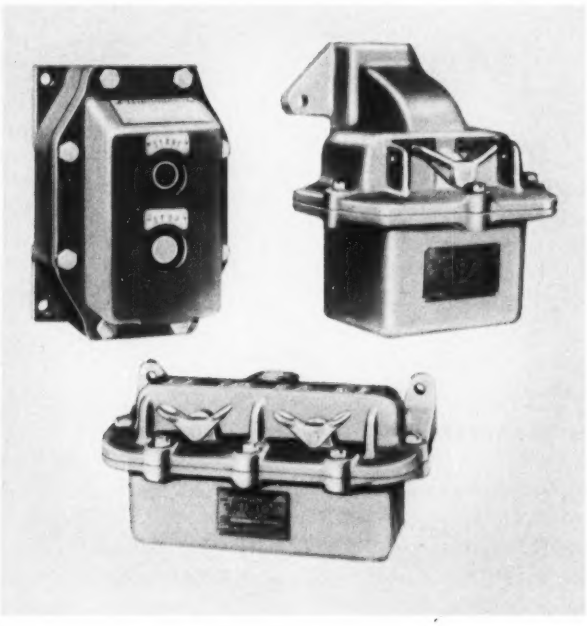
with Life-Line motors, gearmotors and controls

Corrosive solids, liquids, atmospheres, mild chemicals and severe chemicals—all must be reckoned with when applying motors, gearmotors and controls. Westinghouse equipment has been designed to give you maximum protection against the ravages of corrosion.

Life-Line motors, gearmotors and controls are also protected against physical abuse—bumps from passing vehicles—jars from falling objects—shocks from heavy machinery operation. Life-Line "A" motors combine the strength of fine-grained cast iron with the reinforcing of heavy ribs. False operation of contacts under vibration or accidental impact is no problem with the Westinghouse Life-Line Starter . . . the inverted knife-edge bearing is spring loaded and does not depend on gravity for operation.



All types of Westinghouse Controls are available in enclosures especially suited for use in the chemical industry. Linestarters® and combination Linestarters are available in heavy plate or cast-iron enclosures. Oil-immersed starters are available for corrosive and explosive atmosphere applications.



A large variety of Westinghouse Pushbuttons and pilot controls are available with cast-iron enclosures for use in severe operating conditions. Many chemical companies have found it desirable to locate their starters outside the corrosive areas and operate them remotely by these pushbuttons.

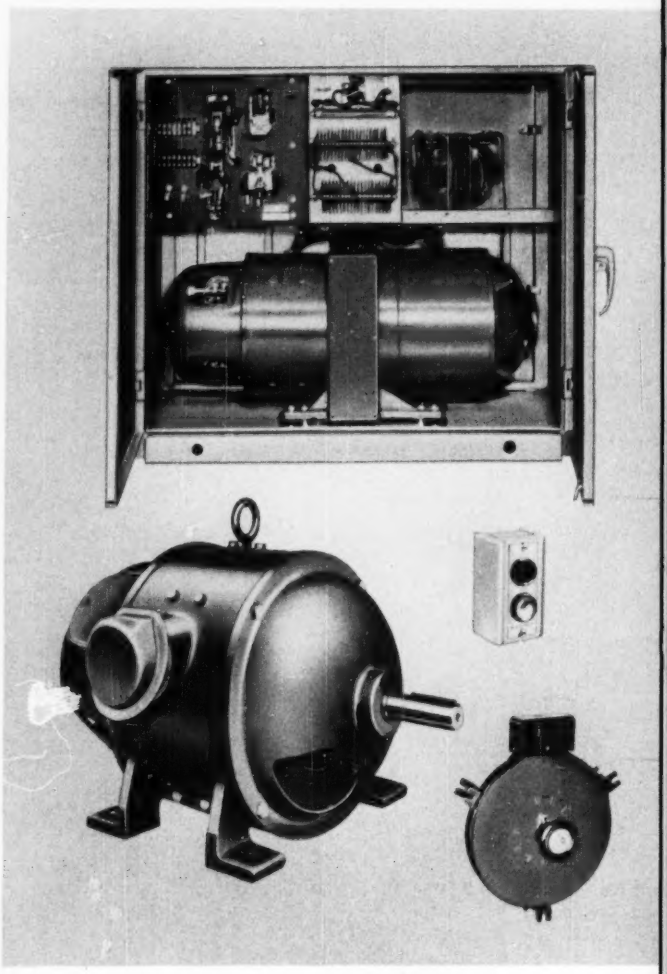
YOU CAN BE SURE...IF IT'S

Westinghouse

Turn to AV Packaged Drives to keep adjustable speed equipment running at peak capacity

The Westinghouse Life-Line AV Drive is a complete, adjustable-voltage drive system—a factory-engineered package. Flexible in application, this packaged drive serves the chemical industry wherever exacting speed control from an a-c power line is required. The Life-Line AV Drive provides: adjustable speed—precise speed regulation—smooth acceleration and deceleration.

Got a tough drive problem that is giving you trouble? Call on the services of a Westinghouse Consulting and Application Engineer. His specialized knowledge qualifies him to analyze fully your specific drive requirements and to recommend the proper equipment.



Here's the backup maintenance and repair service you get when you specify Westinghouse

Westinghouse Maintenance Service is a national organization established to meet all your needs for the repair or overhaul of electrical apparatus. **31 Warehouses,** located in prime industrial centers across the country, carry a well-rounded supply of Westinghouse Genuine Renewal Parts. **38 Specially Equipped Apparatus Repair Shops** are set up to repair every conceivable type of electrical apparatus. **46 Field Service Offices** are ready to make inspections, and on-the-spot repairs for equipment that cannot be moved easily. Ask your Westinghouse Representative how you can take advantage of these facilities. MP-3037

YOU CAN BE SURE...IF IT'S Westinghouse

Gentlemen:

Please send me the following Westinghouse literature:

Name .....

Firm.....

Address.....

City..... State.....

SEND FOR THIS HELPFUL LITERATURE

- ☐ New Life-Line "A" Motor B-6154
- ☐ Life-Line AV Drives B-5808
- ☐ Automatic Operation Start with Westinghouse Control.....B-5882
- ☐ Complete Industrial Control and Services..B-6051
- ☐ Westinghouse Motors and Controls in the Chemical Processing Industries.... .....B-4792
- ☐ Preventive Maintenance.. .....B-5477
- ☐ Life-Line Gearmotors.... .....B-5645

HOW QUICK CAN YOU CLOSE A VALVE?

That depends on the size and type of valve, of course. But with a Rockwell-Nordstrom valve it's only a quarter-turn eased by a film of lubricant.

Another thing—with simple maintenance a Nordstrom valve will never stick or leak in an emergency. The same lubricant that makes turning easy is also a hydraulic jack to free the plug, and at the same time is a leak-closing pressure seal around the valve ports.

Specify the original lubricant seal valve. There's no substitute for Rockwell experience—use it to save money on valves. *Rockwell Manufacturing Co., Pittsburgh 8, Pa.*

THREE WAYS
THE NORDSTROM LUBRICANT WORKS

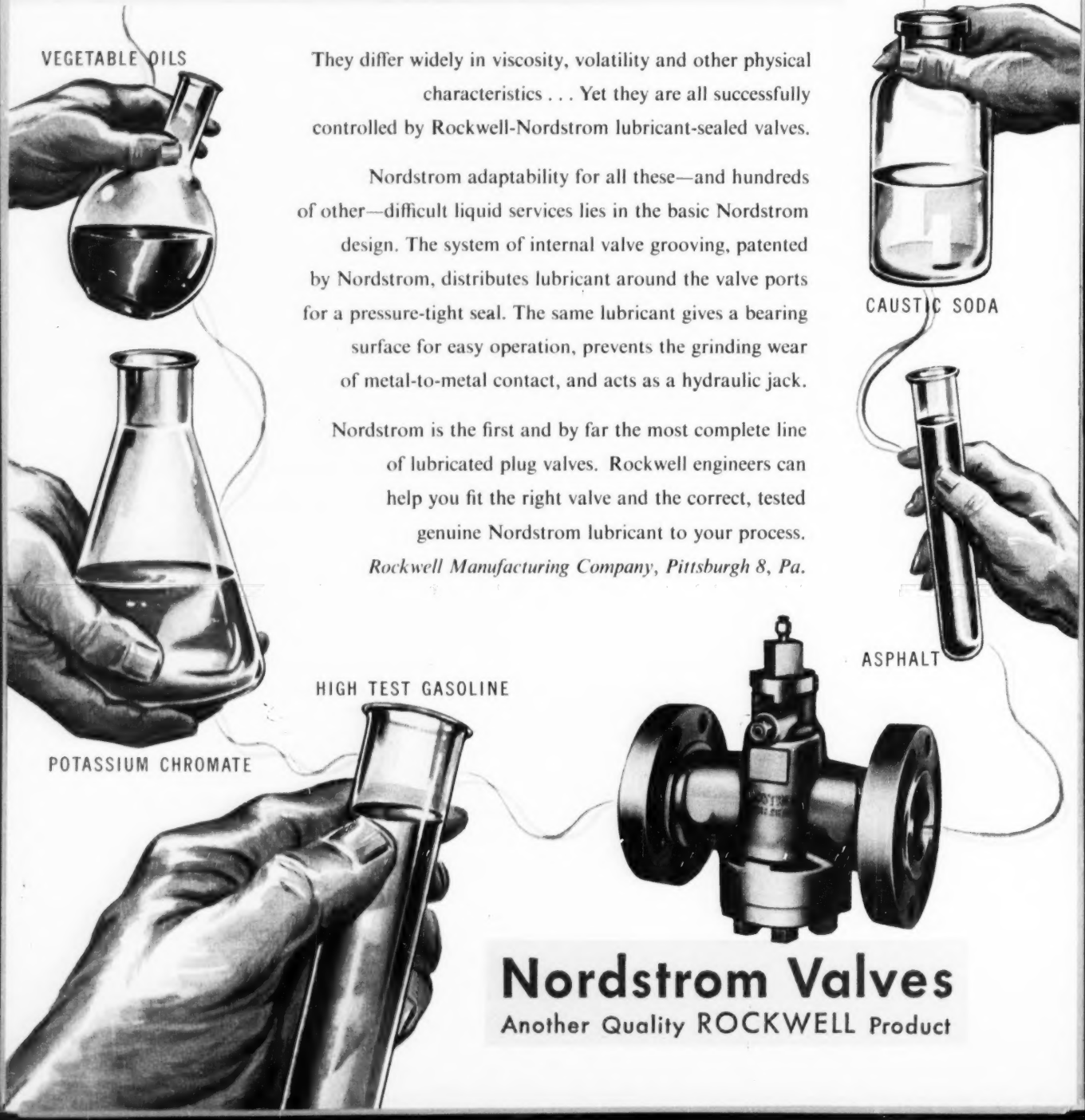
1. Lubricant surrounds each valve port with a vapor tight pressurized seal. **Nordstrom valves stay tight.**
2. Lubricant acts as hydraulic jack—a fast quarter-turn to open or close. **Nordstrom valves operate quickly.**
3. Lubricant coats the plug for sliding action—no wear-producing wedging. **Nordstrom valves operate easily.**

Rockwell Built

NORDSTROM VALVES

Lubricant-Sealed for Positive Shut Off

WHAT DO THESE LIQUIDS HAVE IN COMMON?



They differ widely in viscosity, volatility and other physical characteristics . . . Yet they are all successfully controlled by Rockwell-Nordstrom lubricant-sealed valves.

Nordstrom adaptability for all these—and hundreds of other—difficult liquid services lies in the basic Nordstrom design. The system of internal valve grooving, patented by Nordstrom, distributes lubricant around the valve ports for a pressure-tight seal. The same lubricant gives a bearing surface for easy operation, prevents the grinding wear of metal-to-metal contact, and acts as a hydraulic jack.

Nordstrom is the first and by far the most complete line of lubricated plug valves. Rockwell engineers can help you fit the right valve and the correct, tested genuine Nordstrom lubricant to your process.

Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Nordstrom Valves

Another Quality ROCKWELL Product

NOW-Make Your Own Oxygen and Nitrogen in One Generator

...and Save Up to 50%!

With INDEPENDENT'S newly-designed generators, you can make your own high-purity oxygen and nitrogen from **the free air** . . . and in the **same generator.**

You reduce costs up to 50% by eliminating handling costs . . . vaporizing costs . . . evaporation losses . . . residual losses . . . and transportation costs.

INDEPENDENT Generators are available in any **capacity,** any **purity** and any **pressure.** Put your oxygen-nitrogen problem up to us . . . our engineering department will gladly submit recommendations . . . no obligation, of course!

INDEPENDENT ENG. CO., Inc.

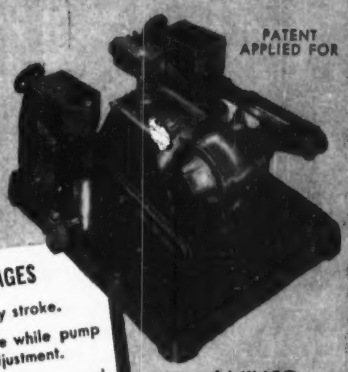
CONSULTING · RESEARCH · DESIGNING

3 PUMPS IN ONE • 7,500, 15,000 or 30,000 psi working pressure made possible by the interchange of piston and cylinder assemblies in the same pump frame

MICRO-FLEX CHEMICAL PROPORTIONING PUMPS

Simplex and Duplex Styles

PATENT APPLIED FOR



CHECK THESE IMPORTANT ADVANTAGES

1. All liquid in the cylinder is displaced at every stroke.
2. Variable delivery—stroke readily adjustable while pump is running. Locking nut maintains stroke adjustment.
3. Stroke adjustment indicating scale is stationary and legible while pump is running.
4. Stainless steel piston and cylinder assemblies for 7,500, 15,000, and 30,000 psi working pressures are interchangeable in the same pump frame. Simplex and duplex styles.
5. Piston reciprocated by positive mechanical linkage to crank arm—does not rely on return spring.
6. Check valves removed easily for cleaning or replacement.

WRITE FOR BULLETIN 4061-A

AMINCO SUPERPRESSURE PRODUCTS

REACTION VESSELS
VALVES • FITTINGS
TUBING • PUMPS
COMPRESSORS
INSTRUMENTS
DEAD-WEIGHT GAGES
PILOT PLANTS

DESCRIBED IN CAT. 406-A

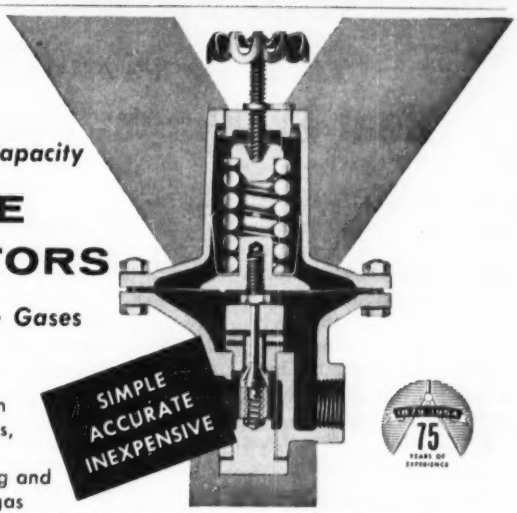
AMINCO *Superpressure Division*
AMERICAN INSTRUMENT CO., INC.
Silver Spring, Maryland • In Metropolitan Washington, D. C.

FOSTER Y-TYPE

Small Bore — Small Capacity

PRESSURE REGULATORS

for Steam • Liquids • Gases



75 YEARS OF EXPERIENCE

Thousands of these versatile valves are in service on unit heaters, cookers, and plastic presses; glass blowing and bottling machinery; gas or oil firing; sterilizers and vulcanizers; instrument control; and low pressure heating.

These valves are unusually sensitive to slight variations in reduced pressure, and give close regulation. Yet they are so simply designed that they present no maintenance problems.

They are built for initial pressures as high as 3000 P.S.I. for air and liquids, 300 P.S.I. for steam; for reduced pressures ranging from ounces to 250 P.S.I. Sizes ¼" through ¾" depending on type. Available in stainless steel alloys. Write for Bulletin Y-101.

FOSTER ENGINEERING COMPANY

835 LEHIGH AVENUE — UNION, N. J.

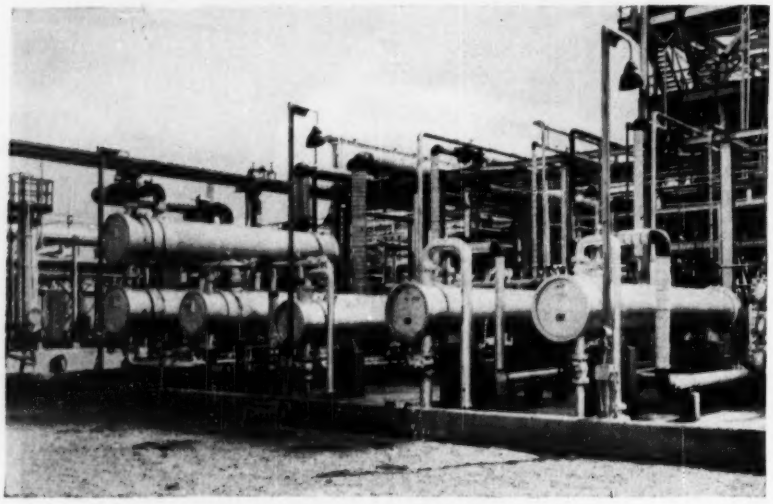
AUTOMATIC VALVES • SAFETY VALVES • FLOW TUBES

BRIDGEPORT BRASS COMPANY

CONDENSER AND HEAT EXCHANGER TUBE EDITION

COPPER ALLOY BULLETIN

Bridgeport Brass Co. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



Choice of Tube Alloys Vital to Economical Heat Exchanger Operations

Heat exchange plays two roles in refinery or process operations. It is an important factor in the technical success of the operation, and, by utilizing excess heat in a cycle, it plays a vital role in that operation's margin of profit. Technically and economically, then, the backbone of profitable heat exchange is selecting the correct alloy for every operating condition.

In petroleum refining and petrochemical processing, the hydrocarbons themselves are virtually noncorrosive to copper and its alloys. But the presence in hydrocarbons of sulfides, chlorides, various acids and bases, solvents, ammonia, carbon dioxide and other gases, and moisture, over a wide range of temperatures, velocities and pressures do cause corrosion.

Adding to the problem, heat exchanger and condenser tubes must withstand the corrosive action of many types of cooling water. The choice of proper metals or combinations of metals is therefore most important.

Hydrogen Sulfide

The most common corrosive materials met in petroleum refining and petrochemical processing are hydrogen sulfide and mercaptans, etc. Long experience has proved that the higher zinc alloys such as Bridgeport Arsenical Admiralty, Arsenical Aluminum Brass and Arsenical Muntz resist sulfur corrosion better than Copper, Red Brass, Duronze IV (Arsenical Aluminum Bronze) and 90-10 Cupro Nickel.

Bridgeport uninhibited Admiralty and Aluminum Brass have given service where desalting, acid neutralization and other processing methods have cut corrosiveness on the product side. While in some cases such treatment allows use of Bridgeport 70-30 Cupro Nickel and Duronze IV, neither of which are highly resistant to sulfur attack but both of which offer distinct advantages toward the water side.

Alloys for Cooling Water

Cooling waters vary considerably from plant to plant. Refineries using sea water or brackish water have the most severe corrosion problems. Where sea water velocities do not exceed five or six feet per second, and debris is absent, Bridgeport Arsenical Admiralty or Arsenical Muntz is usually an economical choice. Sea water velocities above six feet per second are best handled by Bridgeport Arsenical Aluminum Brass, Duronze IV and 70-30 Cupro Nickel.

Bridgeport 80-20 and 90-10 Cupro Nickel can sometimes be profitably used in place of 70-30 Cupro Nickel to handle sea water. Bridgeport 90-10 Cupro Nickel containing 1.0% iron as a corrosion inhibitor, while resistant to circulating sea water, is not as satisfactory as 70-30 Cupro Nickel, Admiralty or Aluminum Brass to products containing sulfides.

All of these alloys show generally excellent resistance to corrosion from fresh waters and many forms of pollution.

Solve Many Problems

Heat exchanger and condenser tubes are often attacked simultaneously inside and outside by two entirely different types of corrosive media. The answer to this problem is Bridgeport Duplex Tubes.

A refinery tried both steel and red brass tubes in an exchange between ammonia and hydrogen sulfide bearing propane gas and river water. The steel tubes failed on the water side every year or two, while the red brass tubes failed on the product side. Bridgeport Duplex Tubes—with low carbon steel to the product and red brass to the water side—gave an average life in this installation from 6 to 10 years.

This is just one of hundreds of cases where Bridgeport Duplex Tubes have solved difficult corrosion problems for long periods at low cost.

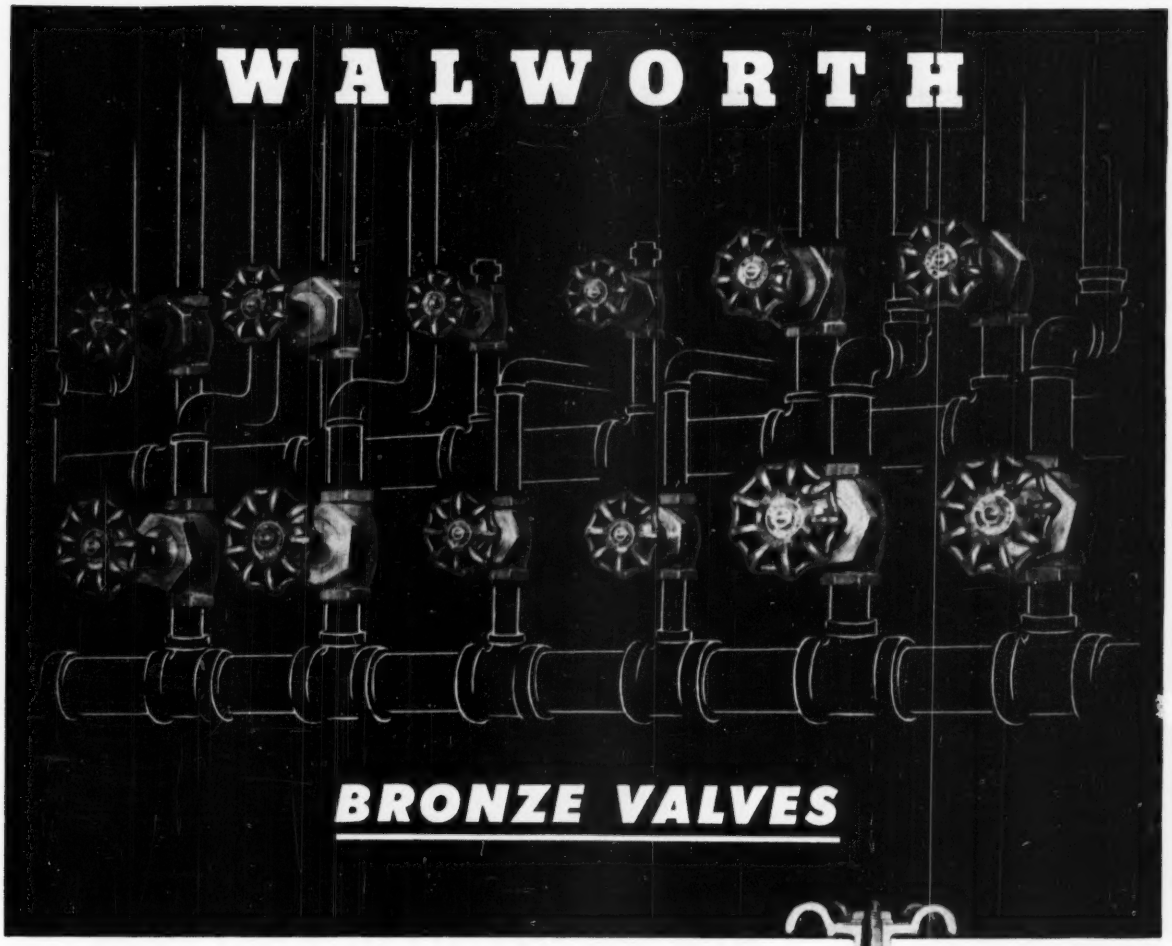
To Help You Select The Right Alloy

Whatever your corrosion problems on heat exchangers and condensers may be, Bridgeport Technical Service will be glad to help you in selecting the correct alloy for long service and profitable operation. Call your local Bridgeport Sales Office for technical advice on your tube problems and prompt service on your requirements.

(1924)

ADVERTISEMENT

WALWORTH

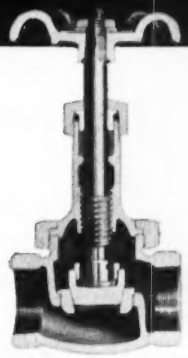


BRONZE VALVES

Better because ... **Walworth has standardized its line of bronze valves to provide an unsurpassed system of interchangeability of parts for assembly or replacement. You can maintain a great number of Walworth Bronze Valves with a small inventory of basic parts ... you minimize part replacement problems. For further information, ask us for our Bronze Valve Standardization Chart.**

Choose from complete lines of Walworth Bronze Valves – including gate, globe, angle, check, and lubricated plug types. Walseal® Bronze Valves and Fittings are also available for making silver-brazed joints.

For full information on Walworth Bronze Valves and Fittings, call your Walworth Distributor, nearest Walworth Sales Office, or write to Walworth Company, General Offices, 60 East 42nd Street, New York 17, N. Y.



Parts are carefully machined and finished to close tolerances, thereby assuring accurate fit and alignment under all conditions. Sectioned valve is Walworth No. 225P Bronze Globe Valve with stainless steel plug-type seat and disc, heat-treated to a minimum of 500 Brinell hardness.

WALWORTH

Manufacturers since 1842

valves ... pipe fittings ... pipe wrenches

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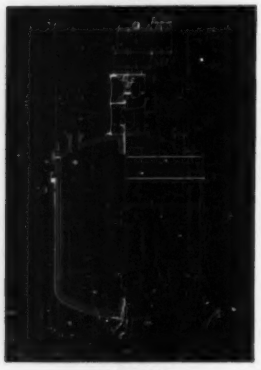
Whatever Your Kettle Need—

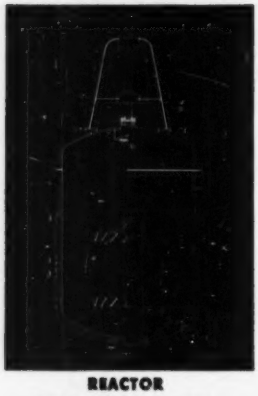
BETHLEHEM Can Meet it

Our competent experienced engineering staff and well-equipped foundry and shops can effectively translate your processing vessels need into efficient, durable equipment.

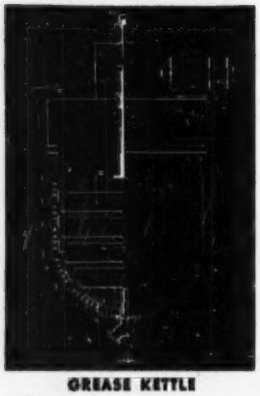
TYPICAL BETHLEHEM VESSELS



REDUCER
Cast-iron kettle and cover; fabricated-steel jacket.

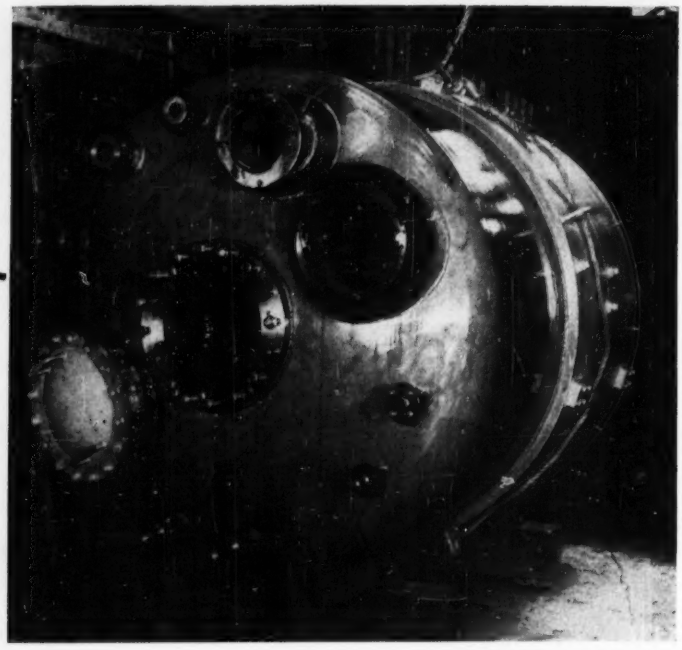


REACTOR
Stainless-clad construction.



GREASE KETTLE
THERMOCOIL (Steel coil integral with cast-iron wall).

Stainless and steel fabricated construction



FOR OVER FORTY YEARS OUR VESSELS HAVE BEEN USED

—for

- **CORROSIVE SERVICE** such as sulfonations, nitrations, reductions.
- **DIRECT FIRED OPERATIONS** such as caustic fusions, sodium bisulfate and carbon disulfide manufacture.
- **HEAVY DUTY NEEDS** such as processing extremely viscous and pasty materials.
- **HANDLING ABRASIVE SOLIDS,** especially in reaction.

Bethlehem manufactures vessels in ***cast metals and fabricated steel, stainless steels, alloys, and clad;*** to ASME Code, other specifications, and company standards. X-ray and other test techniques assure sound construction for demanding service.

You will find it profitable to learn more about Bethlehem processing vessels for reaction, agitation, heat transfer, distillation, sublimation, crystallization, drying.

Write today for 8-page, 2-color folder illustrating and describing our line of fabricated and cast kettles.

BETHLEHEM FOUNDRY & MACHINE CO.

BETHLEHEM **PENNSYLVANIA**

Will your process do better with a Hooker chlorobenzene?

If you use chlorobenzenes in your processing, you may improve results with one of these versatile Hooker compounds.

They are widely used as intermediates in the manufacture of dyestuffs and other organics. But they have other virtues, too—important ones.

For example, two of the Hooker chlorobenzenes listed here have excellent solvent properties. One is highly effective as an insecticide, either alone or in special formulations.

Two are recommended as heat transfer media for condensing vapor systems, above the range conveniently covered by steam.

If you would like technical data on these Hooker chlorobenzenes, just check and mail the coupon. For samples and contract information, please write us, outlining your requirements.

MONOCHLOROBENZENE

C_6H_5Cl

Description: Clear, colorless, moderately volatile liquid, with a characteristic mild odor. Completely miscible with most organic solvents; immiscible with water.

Physical data:

F. P.	−44°C.
Dist. R.	1° incl. 132.0°C.
Sp. Gr., 15.5°/15.5°C.	1.114
R. I., n20/D	1.524
Flash Point	29°C.

USES:

Intermediate in manufacture of insecticides, dyestuffs, drugs, perfumes, and other organic chemicals.

Solvent for paints, varnishes, lacquers; general organic solvent.

Heat transfer medium for condensing vapor systems.

Shipping containers: 5-gal. cans; 55-gal. steel drums; tank cars.

ortho-DICHLOROBENZENE, Tech.

$C_6H_4Cl_2$

Description: Clear, colorless liquid with a characteristic odor. Completely miscible with most organic solvents; immiscible with water.

Physical data:

F. P.	−10° to −22°C.
Dist. R.	4° incl. 179.5°C.
Sp. Gr., 15.5°/15.5°C.	1.310
R. I., n20/D	1.550
Flash Point	79°C.

USES:

Solvent for gums, resins, tars, rubbers, oils, fats, asphalts, sulfur, charred grease and oil.

Degreasing agent for metals, leather, hides, wool.

Insecticide for termites, wood borers, etc., and in anti-fouling paints.

Ingredient of metal polishes, paint and varnish removers.

Heat transfer medium for condensing vapor systems.

Intermediate in manufacture of dyestuffs, other organics.

Shipping containers: 55-gal. steel drums, tank cars.

1, 2, 4, 5-TETRACHLOROBENZENE

$C_6H_2Cl_4$

Description: White crystalline solid with almost no odor. Packaged in flake form. Insoluble in water; soluble in many organic solvents.

Physical data:

Chlorine Content	65.7%
M. R.	137° to 140°C.
Dist. R.	240° to 246°C.

USES:

Intermediate in manufacture of 2, 4, 5-trichlorophenol and 2, 4, 5-trichlorophenoxy acetic acid, and other organics such as azo dyes.

Suggested as impregnant for fire and moisture resistance in electrical and other insulating compounds.

Shipping containers: Fiber drums, 200 lbs. net.

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HOOKER ELECTROCHEMICAL COMPANY
5 Forty-seventh St., Niagara Falls, N. Y.

Please send data sheets on:

- ☐ Monochlorobenzene
- ☐ ortho-Dichlorobenzene, Tech.
- ☐ 1, 2, 4, 5-Tetrachlorobenzene
- ☐ Bulletin 100 describing Hooker products and services.

Name ..... Title .....

Company ..... Address .....

City ..... Zone ..... State .....

HOOKER CHEMICALS

From the Salt of the Earth

4-532

HOOKER ELECTROCHEMICAL COMPANY

NIAGARA FALLS • TACOMA • MONTAGUE, MICH. • NEW YORK • CHICAGO • LOS ANGELES

Sometimes, all you need is the suggestion

Mind you, we do not say that diatomite is the answer to your particular problem—but we do suggest that it may be. For it is, quite literally, amazing how often the unique properties of the finest diatomaceous materials (those which carry the Dicalite name) have proved to be the key to new products or better processes. Chemically inert, being practically pure silicon dioxide, very light in weight, with great surface area, Dicalite is used in filtering everything from antibiotics to zein; as a bulking agent and filler; as extender and as flatting agent; as a carrier and a diluent; and as insulation. As a filteraid, Dicalite provides a wide range of uniform materials which afford high throughput with filtration "sharp" enough to remove solids in the size range of bacteria. • We will be glad to aid you in any way we can. Our technical bulletins are free on request; we will forward samples, sufficient for ample tests, if you will tell us what the problem is. The services of our laboratories and technical department are yours without obligation in the working out of special problems. Just write us.

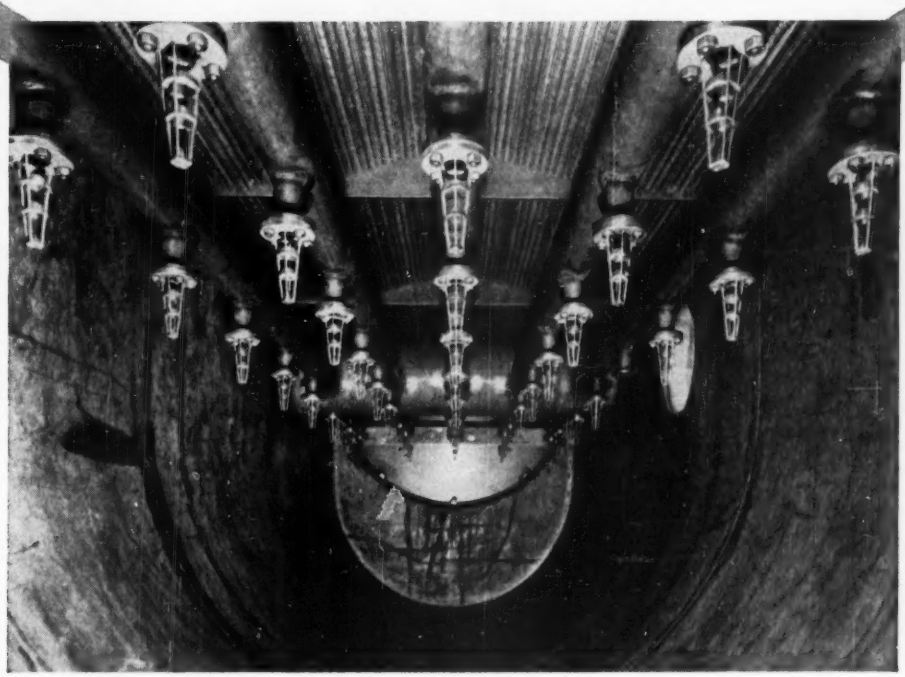
Dependable GREAT LAKES **Dicalite®** DIATOMACEOUS MATERIALS

DICALITE DIVISION, GREAT LAKES CARBON CORPORATION, 612 SOUTH FLOWER ST., LOS ANGELES 17, CALIFORNIA

For Long-Life . . . Easy Maintenance

Carpenter Stainless Tubing

Gets the Call



When job conditions are tough and maintenance costs are critical—you can follow the lead of thousands of chemical processing plants and equipment manufacturers and call for Carpenter Stainless Tubing.

The flash cooler pictured here is an example. Carpenter stainless gives the manufacturer more than corrosion resistance. It also has uniform wall thickness; tight adherence to strict physical specifications; unexcelled quality, from length to length and order to order.

It adds up to the fact that there is a cost-saving difference in stainless tubing and pipe and Carpenter makes that difference. Put this provable difference to work for you. Call Carpenter for prompt delivery and any engineering or design help you may need.

The Carpenter Steel Company, Alloy Tube Division, Union, N.J.

Branch Offices: Atlanta Chicago Pittsburgh
Houston Newark San Francisco

Export Dept.: The Carpenter Steel Co., Port Washington, N.Y.
"CARSTEELCO"

Carpenter

STAINLESS TUBING & PIPE

Analysis → Tolerance → Finish →

- guaranteed on every shipment

THEY TAKE THE MOST CORROSIVE & ABRASIVE MATERIALS IN STRIDE

RHEINHUETTE
CENTRIFUGAL PUMPS
without stuffing box

△ MODEL: RE
WITHOUT STUFFING BOX

RHEINHUETTE PUMPS without a stuffing box are available in many sizes with capacities ranging from 220 to 80,000 g.p.h. and total heads up to 225 ft. Special types with open impellers for acids or lyes containing impurities. Special types with heating jacket for liquids which solidify or which have a tendency to crystallize.

RHEINHUETTE CENTRIFUGAL ACID PUMPS are made of over 25 corrosion resisting metal alloys including Chrome — Nickel — Molly — Cupro alloys — Special RH Silicon Irons, etc. and also pumps lined with Hard Rubber or Antimonial Lead.

RHEINHUETTE
(Wiesbaden-Biebrich, Germany)
CENTRIFUGAL PUMPS · VALVES · FITTINGS For ACIDS and LYES

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Centrifugal Acid Pumps without Stuffing Box • Centrifugal Acid Pumps with Relieved Stuffing Box • Self-Priming Acid Pumps • Screw Impeller Acid Pumps • Centrifugal Pumps with Full-Way Tubular Impeller • Acid and Sewage Sump Pump • Cement Slurry Centrifugal Pumps • All Purpose Centrifugal Pumps.

Our engineers and metallurgical experts—some of the world's most experienced—are ready to assist you in the economical, permanent solution of your pumping problems.

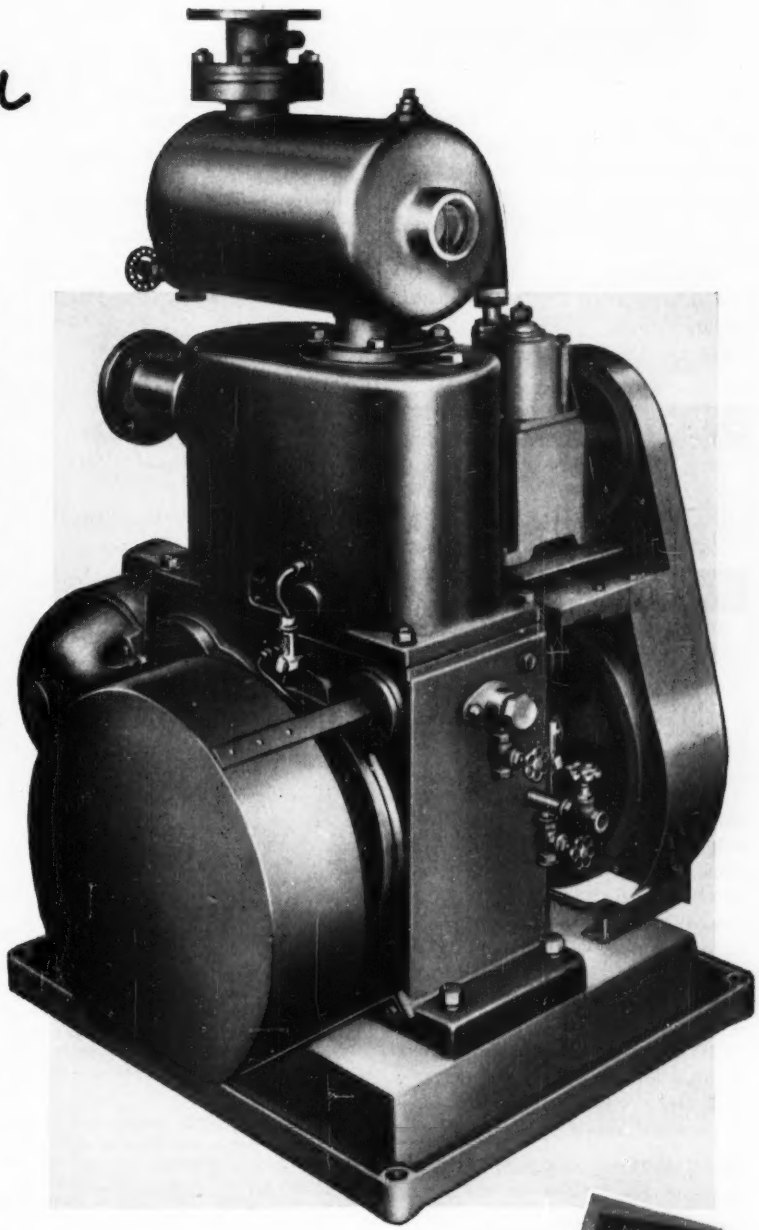
NRC Rotary Gas Ballast Pumps

Shave Minutes Off Pump-Down Time

Experience proves NRC high vacuum Rotary Pumps pump down faster. Employing the revolutionary Gas Ballast principle, they're more efficient both mechanically and volumetrically especially at low pressures. They permit minimum blow back and leakage past the pumping members. Since vapors won't condense in this pump, fast pump down time is always maintained.

Dollars Off Your Pumping Costs

The efficiency of NRC Rotary Pumps makes for substantial savings. NRC's special inlet design screens out dust and foreign matter — protects pump parts from undue wear. Dynamic counter-balancing results in minimum vibration. Easier to service. More dependable to operate. Users report long life, low operating costs under the most adverse conditions.



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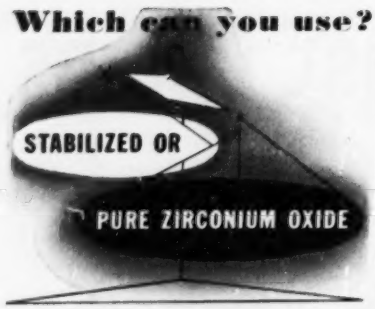
Which can you use?



Both oxides have definite advantages for specific uses due to their particular physical and chemical properties. Study the comparative information given here and see which will answer your requirements best.

Make note of the fact that our pure (monoclinic) oxide can be furnished in the finest grain size obtainable. We believe the purity of our oxides is unexcelled.

Typical Analysis

Pure Oxide (Monoclinic 99.2% ZrO_2)				
SiO_2 .06	TiO_2 .05	Fe_2O_3 .02	Al_2O_3 .02	BaO .003
CaO .56	MgO .04	K_2O .005	Na_2O .004	B_2O_3 .001
Stabilized Oxide (99.7% Cubic)				
SiO_2 .16	TiO_2 .10	Fe_2O_3 .11	Al_2O_3 .05	BaO .003
CaO 5.20	MgO 1.01	K_2O .001	Na_2O .003	B_2O_3 .001

Use Characteristics

Different crystal structures account for the different successful uses of these two oxides. Pure oxide, having monoclinic crystals, undergoes an inversion of crystal structure and a 7 per cent volume change at about 1000° C. The introduction of calcium oxide, during the process of creating stabilized oxide, locks each crystal in a cubic form which remains constant to its melting point of 4700° F. The other important difference between these two oxides is the necessarily larger percentage of calcium present in the stabilized oxide. A-9579

FREE SAMPLES of either oxide are available on request. Perhaps we can help you with your particular application. **Write Zirconium Corporation of America, Solon Center Bldg., Solon, Ohio.**

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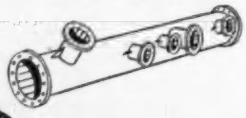

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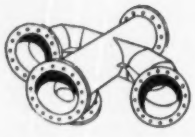

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Fig. 645

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Equipment Wanted Advertising—page 500

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7—Pebble Mills, 800 gal., 6'x8'; 235 gal., 5'x4'; 125 gal.; 50 gal.; 25 gal.
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3—3'x50' Rotary D. H. Dryers or Coolers.
3—Mojonnier S/S Vac. Pans, 3', 4', 6'.
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3—B & J Rotary Cutters, #2, #1.

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1—6"x15' Sturtevant all steel Jaw Crusher.
1—Stainless Steel Link Belt Roto Louvre Rotary Dryer, #502-16, with motor reducer drive, Ross gas or oil furnace, exhausters, etc. Also #207-10.
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1—Swenson Walker Crystallizer 70', jacketed, 20' sections.

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1—250 gal. s/s Tank.
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ALUMINUM, STAINLESS STEEL TANKS SOLVE YOUR STORAGE PROBLEMS:

20—10,000 gal. Aluminum Vert. Tanks—9'10" dia. x 18'10" x ¼"

2— 4,000 gal. Stainless Vert. Tanks—8' dia. x 10'6" x ¼"

11— 4,000 gal. Aluminum Vert. Tanks—8' dia. x 10'6" x ¼"

6— 3,000 gal. Stainless Vert. Tanks—7'2" dia. x 8'9" x ¼"

ALSO HAVE

25— 600 gal. Full Jacket Stainless Vert. Kettles—49" ID x 6' St. Side

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Union, N. J. UNIONVILLE 2-4900

QUICK DELIVERY ON GUARANTEED EQUIPMENT

DRYERS & KILNS

1—Stokes 2' x 6' Rotary Vac. Dryer
Devine #12 Vac. Shelf Dryer 40" x 42" Shelves.
5' x 15' Rotary Kiln brick lined, complete.
2—Albright-Neil 4' x 9' Atmos. Drum Dryers.
1—Buffalo Vac. Drum Dryer 24" x 26".
6—Steam, Gas & Electric Dryers, Tray & Truck.
8—Rotary Dryers direct & indirect, also Jacketed & Steam Tube.
New Seco Rotary Dryers & Kilns, good deliveries.

CENTRIFUGALS & CENTRIFUGES

4—Tolhurst 40" Suspended Type Centrifugals. Bottom Discharge. Motor Driven.
8—Centrifugals 12", 30", 40" & 48" Steel, Copper, Stainless & Rubber Lined.
12—Sharples Centrifuges #5A Stainless. Also #6.
3—De Laval Multiple Clarifiers #200, 300 & 301.

FILTERS

1—Vallez 41 Stainless Covered Leaf Filter, type 49.
Shriver 30" x 30" Iron P&F Filter Press.
10—Sperry & Shriver 12", 15", 18", 24", 30", 36", iron & wood Filter Presses, also disc Type.
Sweetland & Oliver Rotary Vac. Filters.

KETTLES & TANKS

100 gal. Stainless Steel closed agit. Jack. Kettle.
1—Dopp 350 gal. C.I. Jack. Vac. Kettle.
Devine 36" dia. impreg. Unit, closed Jack-Liquor & Impreg. Kettles. Also 100 gal size.
Devine 1000 gal. closed Jack. Steel Kettle.
1—2300 gal. vert. agit. Jack. Steel Kettle.
450 gal. closed, agit. Kettle. Motor driven.
8—Jacketed Kettles 50 to 2500 gals.
1—250 gal. Lead-Lined Kettle.
2—Pfaudler 500 gal. vert. Glass Lined Tanks.
New Stainless Steel Tanks 50 to 10,000 gals.
50—Stainless Alum., Copper, Glass & Lead Lined Kettles & Tanks. Also new Stainless.
1—250 gal. vert. Copper Jack. Kettle.
Copper & Stainless Varnish Kettles.

PULVERIZERS & MILLS

Patterson 30" x 42", 6' x 5', 6' x 8' Pebble Mills.
Abbe 24" x 33" & 30" x 36". Also Jar Mills.
#1 Raymond Automatic Pulverizer 20 H.P. motor.
1—Raymond #00 Pulverizer 30 H.P. Complete.
4—#0000 Raymond Mills.
Buchanan 12" x 12" Jaw Crusher.
Williams 5 Roll Super Titan Roller Mill.
Hammer Mills & Pulverizers 3 to 50 H.P.
1—Schultz-O'Neill 20" Pulverizers. Also #1.
1—Sturtevant 30" Rock Emery Mill.
1—Robinson 18" & 22" Attrition Mills.
1—Lehman 4 Roll W. C. 12 x 36" Steel Mill.
3—Steel 3 Roll Mills 9"x32", 12"x30" & 16"x40".
1—9" x 36" Double Steel Roller Mill.
1—9" x 24" 3 pr. high steel Roller Mills.
3—Houchin 18" x 36", 4 Roll Granite Stone Mills.
Ball & Jewell #1 Rotary Cutter.
2—U. S. & Premier 1½ H.P. Colloid Mills.

MIXERS & SCREENS

Baker Perkins double arm 100, 50 & 9 gals.
5—American Tool 300 gal. Churns.
Horiz. Mixers single & double arm to 200 gal.
1—Day 2½, 8, 15 & 40 gal. Pony Mixers.
1—Century 2 HP. 4 speed Vert. Mixer.
6—Lead & Paste Mixers 50 to 150 gals.
1—Tyler 3' x 5' Vibratory 2 Deck Screen.
Patterson 42" dia. Stainless Conical Blender.
1—Master Drum Type Blender 1000#.
10—Dry Spiral Mixers 50 to 3000#.
12—Portable Elec. Agitators ¼ to 2 H.P.

MISC. & SPECIAL

2—Leominster 8 oz. Injection Molding Machines.
Stokes #280, 4" dia. Preform Machine.
Anderson & French Oil Expellers.
Sly Dust Collector, Bag Type, 242 sq. ft. complete.
150 gal. Post or Change Can Mixer.
Gould 75 HP Centrifugal Pump, 250 PSI.
Pneumatic Scale Automatic Capper M.D.
1—Marco 200 Stainless Steel Homogenizer.
Filling Machines for Powder & Paste.
Liquid Filling Machines & Labelers.
Rotary & Single Punch Tablet Machines, ½" to 4".
1—Howe Mogul Barrel & Bag Packer.
2—Worthington 12" x 12" x 12" Vac. Pumps.
6—Devine Stokes & Buffalo Vac. Pumps.
Soap Machinery for Toilet Laundry, Chip Liquid.
Plastic & Rubber Mills & Calenders.
Plastic & Rubber Hydr. Presses, Extruders & Injection Molding Equipment.
Roller & Screw Conveyors, Portable Elevators.
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89 CFM 6 x 7 Worthington HB, 15 HP Elec
105 CFM Worthington-1R-CPT Portable
107 CFM 7-7 x 7 Ingersoll FS-1 STEAM
122 CFM 7 x 7 Ingersoll ES-1 20 HP
142 CFM Ingersoll Semi-Portable 25 HP
160 CFM 1R-Worth Portable
165 CFM Smith 110SR Semi-Portable, 25 HP
167 CFM 10 x 5 Ingersoll Vacuum Pump-7½ HP
195 CFM 8-9 x 9 Worthington HS STEAM
210 CFM Worthington (GAS or DIESEL) Port
211 CFM 9 x 9 Chicago T-B 30 HP Elec
279 CFM 11-10 x 11 Worthington HS Steam
294 CFM 10 x 11 Worthington HB 50 HP Elec.
315 CFM Worthington (GAS or DIESEL) Port
434 CFM 14 x 7 Ingersoll Vacuum Pump-15 HP
492 CFM 13½/9 x 10 Chicago O-CB Duplex 75 HP Elec
600 CFM Worthington (DIESEL) Portable
628 CFM 14 x 13 Ingersoll ES-1, 100 HP
720 CFM 18 x 7 Worthington HEV Vacuum Pump 25 HP
868 CFM 17/10 x 12 Chicago O-CB Duplex 150 HP Elec.
1184 CFM 22 x 9 Chicago T-VB Vacuum Pump 40 HP
1633 CFM 24 x 11 Chicago T-VB Vacuum Pump 60 HP

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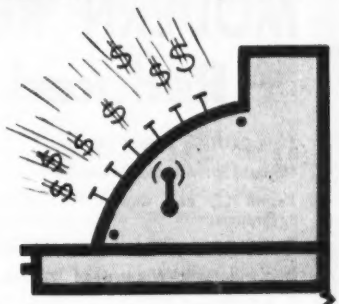

FILLS YOUR TILL 'CAUSE IT "FITS THE BILL"

Dryers—Kilns

3—Reeves 7'x160', 7'x120', ⅜" shell.
1—Vulcan 8'x125' ¾" shell.
2—Allis Chalmers 9'x80', ⅝" shell.
1—F. L. Smidth 4'x30' ⅜" shell.
1—Ruggles Cole 5'x30' Rotary Dryer.
5—Link Belt, Hersey Rotary Dryers 2'7"x8', 3'x24', 3'10"x16', 7'5"x20' stainless steel.
4—Louisville Steam Tube Dryers 6'x50', 6'x30', 5'x28', 3'x20'.
4—Devine Vacuum Shelf Dryers with 20, 14, 6 and 4—40"x43" shelves.
3—Stokes and Buflovak Rotary Vacuum Dryers 30"x8', 3'x15', 5'x30'.
4—Buflovak double drum 60"x144", 42"x90", 36"x84", 32"x52".
1—Devine 2'x4' Vacuum Drum Dryer 316 S.S.
2—Buflovak 6' dia. Crystallizers.

Filters

1—Oliver 1'x1' Rotary-Vac Filter 316 S.S.
2—Oliver Monel 8'x10' Rotary-Vacs.
1—Eimco 8'x8' Rotary-Vac complete with pumps, drives, piping, etc.
8—Oliver Rotary Vacuum 11'6"x18', 11'6"x14', 8'x12', 8'x10', 8'x8', 8'x6', 3'x1'.
2—Sweetland #12 with 72 and 36 leaves.
1—Sweetland #7 with 27 leaves.
1—Sparkler #33-S-17 steel filter.
3—Vallez 500 sq. ft., Rotary Pressure.
1—Shriver 36" P&F 42 chambers.
4—Shriver 30" P&F 30 chambers.
8—Sperry 24" P&F, 16 chambers.
2—Sperry Aluminum 30" and 24" P&F.
10—Shriver, Sperry Filter Press Skeletons 42", 36", 30", 24", 18".

Centrifugals

1—Bird 48" Suspended Monel.
1—Bird 40" Suspended 347 S.S.
2—Bird 40" Suspended, rubber covered.
1—Fletcher 30" Suspended, steel.
1—Tolhurst 26" Suspended, steel.
2—Tolhurst 30" center slung steel.
1—Bird 36"x50" solid bowl, stainless.
4—Bird 36"x72", 36"x50", 18"x28" solid bowl, continuous.
1—Sharples Super-D-Canter PY-14, 316 S.S., 10 HP motor.
1—Sharples Nozljector DH-2, 304 S.S., 15 HP motor.
2—Sharples C-27, C-20, Stainless Steel Super-D-Hydrators.
2—Sharples #16P Monel and SS Super Centrifuges.

LIQUIDATIONS

Texas Petrochemical Plant

Towers & Columns

1—8'x61'6" stainless steel, 15 trays.
1—7'x25'6" stainless steel, 10 trays.
1—6'x54' stainless steel, 15 trays.
1—6'x45' stainless steel, 15 trays.
1—4'x110'6" stainless steel, 45 trays.
1—2'x75' stainless steel, 45 trays.
8—Steel Columns 2'-8' dia. x 42'-75' high.

Heat Exchangers, Condensers

2—1440 sq. ft. stainless steel 75# pressure.
2—1125 sq. ft. stainless steel 55# pressure.
1—400 sq. ft. stainless steel 75# pressure.
3—150 sq. ft. stainless steel 850# pressure.
1—100 sq. ft. stainless steel 70# pressure.
2—83 sq. ft. stainless steel 100# pressure.
1—50 sq. ft. stainless steel 100# pressure.
1—31 sq. ft. stainless steel 100# pressure.
12—Steel 10-1350 sq. ft.

Other Items

3—Union Boilers 30,000# steam per hr. 225# W.P.
5—Clark Air Compressors 800 BPH, 2N, 4 stage.
1—Complete oxygen production plant.
12—6'x30' ASME Storage Tanks 75# pressure.
20—Storage Tanks 1000-10,000 bbls.
90—Centrifugal Pumps with turbine drives.

Illinois & Indiana

1—Vulcan 8'x125' Rotary Kiln.
1—Link Belt 7'x45' Rotary Kiln.
1—Vulcan 4½' x 50' Rotary Dryer.
2—Raymond #1 Pulverizers with 5'6" dia. double whizzer separators.
2—Raymond 5 and 3 roll, High Side Mills.
1—Vulcan 325 sq. ft. long tube monel Evaporator. NEW.
1—Louisville 6'35' Rotary Steam Tube Dryer.
9—Bucket Elevators 25'x70' centers, 6"x4" to 12"x6" buckets.
1—I.R. 60 HP Compressor Imperial #10 12"x 7½"x12".
1—Williams 24"x24" Hammermill.
1—Jeffrey 18"x16" single roll Crusher.
1—Stedman 30" dia. 4 cage Mill.
3—250 KVA Transformers 2300 volt primary 460/230 volt secondary, 60 cycle.
2—G.E. pyranol Capacitors 180 and 120 KVA, 460 volt, 3 phase.

Send for complete details

Pulverizers—Crushers

4—Abbe 6'x10' porcelain lined, jacketed, Pebble Mills.
2—Raymond 5 and 3 Roll High Side Mills.
4—Hardinge Mills 4½'x16", 5'x22', 5'x36", 6'x22", 10"x48".
1—Bauer 36' Attrition Mill 2-50 HP motors.
6—Patterson 6'x8', 5'x6', 4'x5', 2½'x3½', brick-lined Pebble Mills.
5—Abbe 3'x4', 3'x3½' Pebble Mills.
2—Premier Collo'd Mills 8" dia., S.S.
1—Jeffrey 30"x25" Hammer Mill, Type A.
3—Raymond, Gayco Separators 12', 8', 6'.
4—Mikro #18I, #18H, #2DH.

Screens

1—Patterson single deck 40"x84" S.S.
1—#42 Rotex double deck 40"x84".
2—#12 Rotex double deck 20"x48".
4—Tyler Hummer 4'x15', 4'x10', 3'x10', 3'x5', single deck with V-16 Vibrators.

Mixers

5—Baker Perkins 300, 100, 50, 1 and ½ gal. sigma blades, jacketed.
1—Baker Perkins 50 gal. JEM, 50 HP.
1—Baker Perkins 35 gal. S.S. jacketed.
1—Robinson 4000# steel powder.
6—Rodgers 400 to 3000# powder.
4—Simpson Intensive Mixers #0 and #00.
9—New Portable Agitators ¼ to 5 HP.
4—Day, Ross 8 and 50 gal. Pony.

Kettles—Still—Condensers—Tanks

1—Pfaudler Reactor glass lined 500 gal.
6—Buflovak, Zaremba and Kilby Evaporators 300 to 14,000 sq. ft.
9—Heat Exchangers, S.S. 50 to 1000 sq. ft.
5—Buflovak Condensers 20 to 90 sq. ft.
2—Groen 125 gal. S.S., jcktd., agitated Kettles.
1—2800 gal. 316 S.S. Tank with coils.
3—2300 and 1400 gal. Aluminum Tanks.
6—Glass-lined Storage Tanks 6000 and 9000 gals.

Miscellaneous

7—Stokes Vacuum Pumps 10 to 100 CFM.
10—Stokes DD2, D52, D4, D3, B2 and R Tablet Machines.
5—Nash TS12, 1S8, L3, AL672, #4 Vacuum Pumps.
2—Cumberland #0 Rotary Cutters.
4—Olivite, Duriron rubber and stainless steel Centrifugal Pumps 1" to 6".

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Elgin 24-Head Rotary Capper.

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Triangle Elec-Tri-Pak G2C, A6CA Fillers.

Filler 4-Head and Hope 6-Head Stainless Steel Piston Fillers.

650 to 850 gal. Jacketed Mixing Tanks.

Standard Knapp 429 Carton Sealer.

Fitzpatrick Stainless Steel Model D Comminuter, 7½ HP.

Mikro 4TH, 3TH, 3W, 1SH and Bantam Pulverizers: Schutz O'Neill Mills.

3500 gal. working cap. Steam Jacketed, Double Arm Mixing Tanks for mixing, storing or processing of your materials.

Day 650 gal. Jumbo Steam Jacketed Mixer.

Koven 2000 gal. Spiral Jacketed Mixer.

Baker Perkins 150 gal. Unidor S. J. D. A. Mixer.

Stokes, Day New Era, Hottman Mixers, from 2 to 450 gal., with and without jackets, Single, Double Arm Agitators.

Baker Perkins and Readco heavy duty, 3 to 160 gals., Double Arm Jacketed Mixers with Sigma or Fish Tail Blades.

Robinson 20x48 Two Deck Sifter.

Tyler Hum-mer #27 Two Deck Sifter.

Day 100, 800, 1500, 10,000 lbs. Dry Powder Mixers and Sifters.

World and Ermold Rotary and Straight-away Labelers.

Oliver Sweetland #2, Sparkler, Stainless Steel, Alsop Filters.

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Oliver cellophane adjustable Wrapper.

Hayssen Auto. Wrappers, all models.

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Package Machy. FA2, FA4, FA Wrappers.

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- Sparkler, Model 18-D-4, stainless 1 HP pump
- Sperry 18" cast iron, 40 plts-frme cor feed
- Sperry 36" wood, 25 frme 24 plts hydr clos
- 8'x3' Dorreo Vacuum, monel screen, pump, mtr
- Swenson 4'x1', rotary cont. Open wood drum
- Oliver 4'x3' rot cont. Iron cont. Complete
- Feino rotary 4'6"x6' cont. Vapor-tite pumps
- Oliver 6'x4' rot cast iron. 2 Nash Pumps
- Elmco 8'x6' rotary continuous, pract new
- Oliver Proconst 8'x10' rot cont. Iron cont
- Sweetland #12, 48 lvs 3" centers. Hydr. clos

MILLS

- Micro 24" Pulverizer, screw feed, 40 HP
- Raymond #1 Imp Mill, flat belt dr excellent
- Raymond 5 roller high side Mill. Dbl whizz
- Fitzpatrick Model D Comminuting. Stainless
- Premier U-3 Colloid, stellite motor, 30 HP
- Moore 4'x3' Ball Mill, 10 HP
- Patterson 4'x3' Pebble Mill, Buhrstone lin
- Allis-Chalmers 5'x22' Tube Mill, 100 HP
- Hardinge 6' conical Ball Mill, 50 HP
- Day 12"x32", 3 roll Mill, water cooled
- Lehman 16"x40" 3 roll Mill, water cooled
- Williams Model 2200 Hammermill, 50 HP ea (2)
- Dixie Hammermills, Model 3620 Non-Clog 75 HP

MISCELLANEOUS

- Autoclave, 500 gal. steel 42" I.D. 78" long
- Crutcher, Dopp 135 gallon, steam jacketed
- Crystallizer, Swenson cont. vac. 4'0" diam
- Emulsifiers, Case S.S. cont with 5 HP dr (6)
- Multiclone, type 9-VG12-130-10, New in crate
- Separator, Raymond 6' double whizzer 7½ HP
- Scale, Richardson, 1000# stationary, encl.
- Thickener mechanism 16'x8' Southwestern

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Dings-Rowand-Wheatherill. 100,000 Ampere Turn. 18" Endless Belt, 3 Cross Belts, Gear Head Motor Drive with Motor Generator. Unit Complete. Can be seen operating.

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GLASS LINED TANKS — USED — 3000 gallon capacity. Welded construction — Fully insulated. Equipped with manhead. Suitable for milk, food products, lily white chemicals, solvents and fine lacquers.

VARNISH TANKS — USED 54" diameter x 14'6" high (or long) ¼" Steel — Welded construction — 1700 gallons.

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BIRD CONTINUOUS CENTRIFUGE—36" x 50"—S. S. Type 304.
HEAT EXCHANGER-GRISCOM RUSSEL, 49-1" SS Tubes, 135 sq. ft.
MIXERS—Double Arm Sigma Blades, SS Arms & Trough. 12, 30, 60 & 200 Gal. Jacketed 100 PSI.
KILN—10' 8" dia. x 120'; ¾" plate complete with 15 hp. motor and drive.
KETTLES—GROEN, All SS, 100 PSI Jackets, 2—NEW 50 Gal., 2—60 Gal.
FILTER PRESS—SHRIVER—30" x 30"—24—3" Frames, Open Delivery, Washing.
KETTLES—250 Gal. Steel, Jacket—100 PSI, ASME Code, New.

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PULVERIZERS—Wms. GA30—30x24—Sturtevant #1 Ring Roll.
FORK LIFT TRUCKS—7500# cap. Hysters—New Engines, pneu. tires.
MIXERS—Simpson 1½—Lancaster EAG 4 W & P 50 gal, double Sigma w/motor drives.
ROTARY KILNS-DRYERS 4x20, 5½x45, 6x88.
PEBBLE MILLS—4 gal.—100—235 (1-new) 640-2000 gallon with motor drives.
HARDINGE MILLS—3'x8", 6'x22"—7'x48" Pebble.
KETTLES—Aluminum 275 gal—500—100 gal, jacketed-agitated.
CRUSHERS JAW—2x6—9x15—11x26.
SCREENS—Tyler 3x5—Single/Triple deck.
BLENDERS—NEW—Ribbon type, 200—400—600# cap. center discharge.
PUMPS CENTRIFUGAL—Stainless, Rubber, C.I. & New A.C. 6000 gpm 45'—100 HP deep well.
FILTER PRESSES—Cast iron—12" closed, wash—36" open, wash—62 ressd plates.

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PUMPS—Priced Right

2—Viking single units, Model DQ, 200 GPM capacity, direct connected to 5 HP exp. proof gearhead motor, 3/220-440/60. Priced at $475.00 @ f.o.b. Racine, Wisc.

1—Viking single unit, Model DM, 300 GPM capacity, direct connected to 7½ HP exp. proof gearhead motor, 3/220-440/60.

Rotary pumps 50 to 450 GPM capacity, write for complete listing.

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1—Bubble Cap Column, St. St. (400 Series) 64" dia. x 13 plates.
3—Baffle Plate or Cascade Columns or Towers, T304 stainless steel, 5' dia.
3—Aluminum Bubble Cap Columns, 36".

CONDENSERS—EXCHANGERS

18—from 14 to 700 sq. ft.—Shell and tube and Coil type.
15—Alum. Coil Exch. 47 sq. ft.
5—Copper tub. 65, 90, 1350 sq. ft.

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LOUISVILLE ROTARY STEAM TUBE DRYER 6' x 40'
LOUISVILLE 8-ROLL DEWATERING PRESS, 36"
LOUISVILLE ROTARY PADDLE SCREEN, 36" x 18'
DOUBLE DRUM DRYER, 24" dia. x 60" long
CONKEY TRIPLE EFFECT EVAPORATOR. Herculoy construction
1st effect—Forced circulation—500 sq. ft.
2nd effect—Natural recirculation—700 sq. ft.
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FILTERS

2—International T304 St. St. #3 (24" dia.) and #5 (33" dia.)
2—Sweetland #10 & #12.
1—Swenson Rotary Continuous Vacuum Filter; Precoat type, 8" dia. x 8' face, rubber covered and lead acid proof.
1—FEINC Aluminum Rotary Vacuum string discharge, 4'6" dia. x 6'.
1—Oliver Precoat 5'3" x 3', Rubber lined, pressure housing.
8—P & F Filter Presses, 12" to 36".
4—Pressure Leaf Filters, 70 to 140 sq ft.

KETTLE—REACTORS

3—13 gal. Autoclaves, T347 St. St., 700# int. WP., 50# Pkt. WP.
1—St. St. T304 Pressure vessel, 18" dia. x 9'4" long, 600# W.P.
3—Stainless Steel Kettles, Jktd. & Agit., closed, 100 & 450 gal.
70—Stainless Steel and Stainless Clad open top, steam jacketed kettles—40, 60, 100, 150, 200, 500 gal. sizes.
4—Aluminum Reaction Kettles, Jktd. & Agit., 35, 60, 100 gal. and 250 gal.

JUST PURCHASED

1—60 gal. Dbl. Arm Sigma blade, non-jktd. dough mixer
1—2500 gal. Horiz. St. St. closed Tank
4—Vert. St. St. Tks., 300, 450 & 1000 gal.
1—Pfaudler 100 gal. Glass Lined Jacketed Agitated Reaction Kettle
1—W & P 100 gal. double arm jacketed mixer, sigma blades.
3—42" dia. Sieve Plate Columns, steel shell 22' high, 18 plates, T316 stainless steel.
1—Read 1 Qt. Double arm jacketed mixer, sigma blades, stainless steel
1—Day 10 gal. Double arm jacketed mixer, sigma blades, st. st.
2—Blaw-Knox ½ gal. Autoclaves, stainless steel, agitated 2000# pr.
1—6' D x 8' L Pebble Mill, Porcelain Lined
1—Stokes Jacketed Rotary Vacuum Dryer, 3' dia. x 15' long

TANKS

25—Aluminum closed, to 4000 gal.
30—Welded Steel Tanks from 3800 gal. to 13,700 gal. sizes.
5—15,000 gal. Vertical Welded Steel Closed Fermenting Tanks. 80 lbs. WP., turbine agitator with 40 HP motor; 970 lin. ft. 3" pipe coil.

STAINLESS STEEL TANKS

3—T347 Pr. or Vac.—50 & 235 gal.
2—T316 Pr. or Vac.—35 & 160 gal.
10—T304 Pr. or Vac.—9, 150, 160 & 260 gal.
1—T304 600# pr.—86 gal.
50—Stainless Steel Storage Tanks—from 15 gal. to 8200 gal. sizes.
1—3000 gal. Horiz., 5'4" dia. x 18'9" long, insulated and agitated.

MISCELLANEOUS

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1—Tolhurst Susp. Centrifugal 26" dia. steel, imperf., bot. disch.
1—Sharples #16P St. St. Pressure-tite Centrifuge.
5—DeLaval Centrifuges, models #600, 74-11 and 94-01.
2—B & J Rotary Cutter, St. St. #1½ Std. Ideal.
3—Witteman Co. Atmospheric Double Drum Dryers, 22" x 38", (1) St. St.
1—Kennedy Van Saun 3' x 6' Air Swept Contin. Ball Tube Mill.
1—Williams Hammer Mill type AK; size A, stainless steel and aluminum.
4—Mikro Pulverizers—Bantam, #1-SH, #2-Si, #2-TH.
4—Powder Mixers—40, 50 & 100 cu. ft.
2—Kux Machine Co. Model 25 Rotary Pellet Presses, 21 and 25 punch.
4—Selectro Vibrating Screens, stainless steel, 2' x 7', double deck, enclosed.
1—Stokes Vertical Steel Jacketed Vacuum Chamber and Impregnating tank, 30" L x 25" W x 24" D.
1—Baker-Perkins #14—JEM Universal Mixer, Jacketed, Vacuum Cover, 50 gal. work. cap., 50 HP motor.
1—Porter heavy duty jacketed double worm mixer—75 gal.

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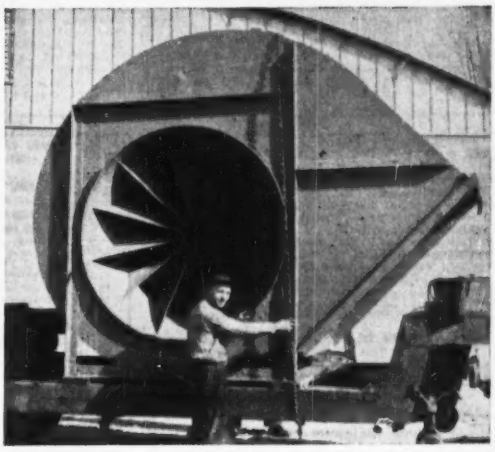

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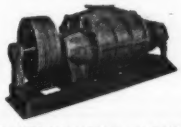

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Roots-Conn.	24x23	RCDH	10	8610
Roots-Conn.	10x7½	RCD	10	440
Roots-Conn.	10x10	RCR	10	616
Sutorbilt	8H	Cal.	10	272
Sutorbilt	6H	Cal.	10	128
Sutorbilt	5H	Cal.	10	66
Sutorbilt	4H	Cal.	10	39
Roots-Conn.	76	AF	7	200
Roots-Conn.	53	AF	7	70
Roots-Conn.	10x12	RCS	7	614
Sutorbilt	6M	Cal.	6	189
Sutorbilt	5M	Cal.	6	115
Sutorbilt	4M	Cal.	6	76
Sutorbilt	3M	Cal.	6	31
Roots-Conn.	710	AF	5	350
Roots-Conn.	67	AF	5	164
Roots-Conn.	44	AF	5	98
Roots-Conn.	33	AF	5	38
Roots-Conn.	22x36	RCD	5	5500
Roots-Conn.	14x18	RCD	4	2150
Sutorbilt	18x42	XB	4	5320
Sutorbilt	14x36	XB	3	3070
Roots-Conn.	717	AF	3	650
Roots-Conn.	615	AF	3	360
Roots-Conn.	59	AF	3	205
Sutorbilt	5L	Cal.	3	249

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Make	Size	HP	Volume c.f.m.	Pressure Oz.
Allen-Billmyer	ED5BS	30	410	96
Allen-Billmyer	DAS	15	225	96
Spencer	5060-H	75	1700	80
Spencer	Special	200	8200	48
Gen. Elec.	Special	10	450	48
Allen-Billmyer	D-6	7½	275	48
Gen. Blower	2425-1	25	2500	24
Ingersoll-R	FS377	150	15000	20
Ingersoll-R	FS377	85	10500	20
Spencer	1230	30	3350	20
Spencer	1215	15	1675	20
Power Engin.	2010	10	1150	20
McKee	16621-1-½	7½	500	20
N. American	15G2	5	700	19
Gen. Blower	1630	30	3600	18
Spencer	1010-A	10	1500	16
Gen. Blower	1610	10	1300	16
Eclipse Fuel	6819	10	1200	16
N. American	1716E	7½	1100	16
Spencer	1097	7½	1000	16
N. American	1716E	5	675	16
Spencer	1005	5	600	16
Spencer	1001	1	110	16
Eclipse	2-1-½	1½	100	15
Mohr	503-½	1½	170	14
Sturtevant	170-225	60	10100	13
Mohr	505	5	875	12
Spencer	0755	5	850	12
Spencer	075-½	½	60	12
Eclipse	2-1	1	150	10 5

INDUSTRIAL EXHAUSTERS

Make	Type	Size	Type Wheel	Wheel Diam.
Alington-Cur.	SS	80	SS	64
Sturtevant	ME	70	SS	56
Alington-Cur.	SS	70	SS	56
Buffalo	SS	70	Cotton	48
Alington-Cur.	SS	60	SS	48
Buffalo	SS	50	Wool	45
Sturtevant	SS	55	SS	44
Sturtevant	SS	50	SS	40
Garden City	Cycloid	55	Cycloid	39
Clarage	IE	23	Open	36
American	E	55	Open	36
Sturtevant	Des. 1	55	Rim	33
Sturtevant	Des. 2	45	SS	32
Cyclone B. P.	SS	40	SS	29
Garden City	SP	30	Cycloid	28
Sturtevant	Des. 2	35	SS	27
Buffalo	SP	40	Rim	26
Bayley	SS	30	SS	25
Sturtevant	Des. 2	40	Rim	24
American	E	35	Rim	23
American	E	35	Rim	23

CENTRIFUGAL FANS

Make	Size	Type	Wheel Diam.	Inlet Diam.
American	9	AHS	53⅝	61
New York	49	ME	49	53⅜
Buffalo	8	CL	48	48
American	7	HV	44	50 ½
American	6½	B/C	39⅝	45 ¼
Bayley	8	I	40	41
Sturtevant	8½	Des. 6	39 ½	40 ¾
Bayley	7	B/C	38 ½	39 ⅝
U. S. Air	39	M	40	34
Clarage	3	HV	39	40 ¾
Thermo Ht Fan	60	MIH	37¾	36
American	6	HS	36	37 ¾
Buffalo	6	LL	36½	37 ¾
U. S. Air	36	B/C	36	37 ¾
New York	36	ME	36	39 ½
Sturtevant	85	SV	35	36 ¾
American	5½	HS	33	35
Sturtevant	7½	M	33	35 ½
American	5	Sirocco	30	32
Clarage	2¼	W	29 ¼	30 ⅝

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2—Heat Exchangers, S.S., 9 sq. ft. surface.
1—Stainless Tank #430 Chrome, vert. 7'x10' deep.
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1—Day Mixer, steam jacketed, 50 gal. Sigma Blade.
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1—Copper Evaporator, steam jacketed, 9'1"x3'9".
80—New Pressure Cookers, 18"x18" & 24"x28".
1—New Glass Nash Centrifugal Pump, 160 gpm.
1—Jeffrey Vibrating Conveyor 15' lg. 12" wide.
1—Buflovak Jacketed Impregnating Tank 42"x52".
1—4x8 Sturtevant Jaw Crusher.
1—Ribbon type Mixer, steam jacketed.
3—New Drum Rollers.
2—Nash Air Compressors, Type AL-623.
1—Manton Gaulin Stainless Homogenizer, 125 gph.
1—Ghrivar 18" Aluminum Filter 9-plates 9-frames.
1—Rotary Dryer direct fired 54"x30'6".
1—Kennedy-Van Saun Rotary Dryer, 4'x40'.
Davenport Rotary Steam Tube Dryer, 6'x36'.
1—Gruendler Hammer Mill, 10 H. P.—new.
2—Ransome Rotating Drum Mixers 9' dia. x 11'x6".
1—#316 stainless Reactor, 265 gals. cap. jacketed.
Abbe Pebble & Tube Mill, 5'x22'—Burr-Stone Lined.
1—Patterson Ball Mill, porcelain lined, 17"x27".
1—Patterson Ball Mill 42"x36" jacketed.
3—Dopp Kettles with agitators, 600 gal. cap.
45—Steel Tanks from 100 to 100,000 gals.
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Robinson Pulverizer #20, with 2 motors 10 HP each.
Robinson Ribbon Type Mixer, 30"x10'—like new.
6—Steam Jacketed Blackburn-Smith Filters.
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6—Vertical Stainless Steel Storage Tanks, 3,000 gal. each.
1—A. O. Smith Stainless Steel Vertical Tank, 7,500 gal., 110 lbs. psi.
2—Stainless Steel Storage Tank, 7,200 gal. each, 60 psi.
1—Type 347 Stainless Steel Storage Tank, 1,600 gal.
1—Type 316 Stainless Steel Storage Tank with coil, 3,000 gal.
36—Stainless Steel Open Top Jacketed Kettles, 600 gal. ea.

DRYERS—KILNS

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2—Buflovak Double Drum Dryers, 24" x 36".
1—Buflovak Double Drum Stainless Steel Laboratory Dryer, 6" x 9".
1—Link Belt Steel Roto Louvre Dryers, 7½' x 20'.
1—Stokes Rotary Vacuum Dryer, 3' x 12'.
1—Vulcan Rotary Kiln, 7' x 120'.
1—Buflovak Double Drum Dryer, 32" x 90".
1—Louisville Steam Tube Dryer, 6' x 50'.
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1—Louisville Experimental Laboratory Dryer, 12" x 7½'.
9—Devine Vacuum Shelf Dryers, 5, 9 and 10 shelves.

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2—Bird Type 316 Stainless Steel Filters, 18" x 24".
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1—Oliver Homogenous Lead Filter, 8' x 8'.
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1—Bird 24" Monel Screen Type Centrifugal Filter.
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1—J. H. Day Stainless Steel Double Arm Jacketed Sigma Blades Mixer, 150 gallon capacity.
1—Baker-Perkins Steel Jacketed Double Arm Sigma Blades Mixer, 200 gallon working capacity. Year built 1948.
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1—Mikro #3W Pulverizer.
1—Abbe #2 Buhrstone lined Pebble Mill, 5' x 4'.
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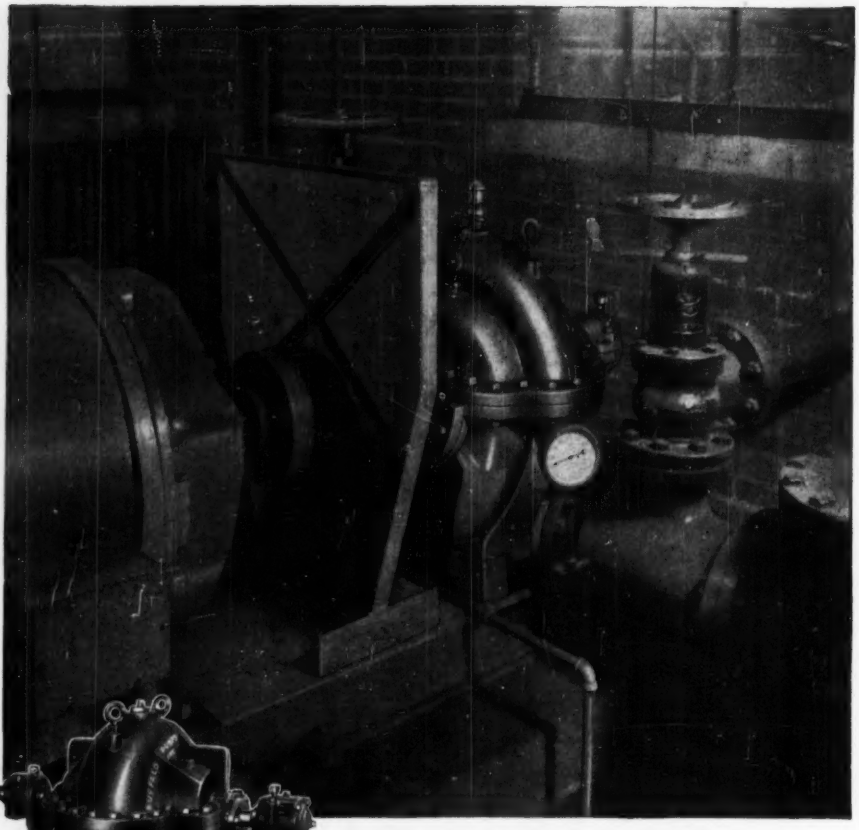

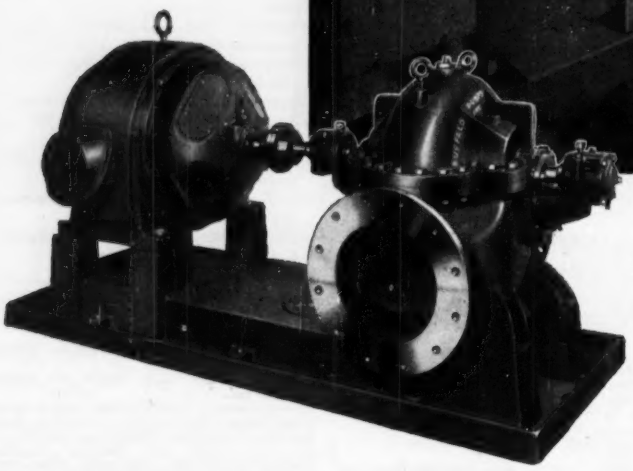

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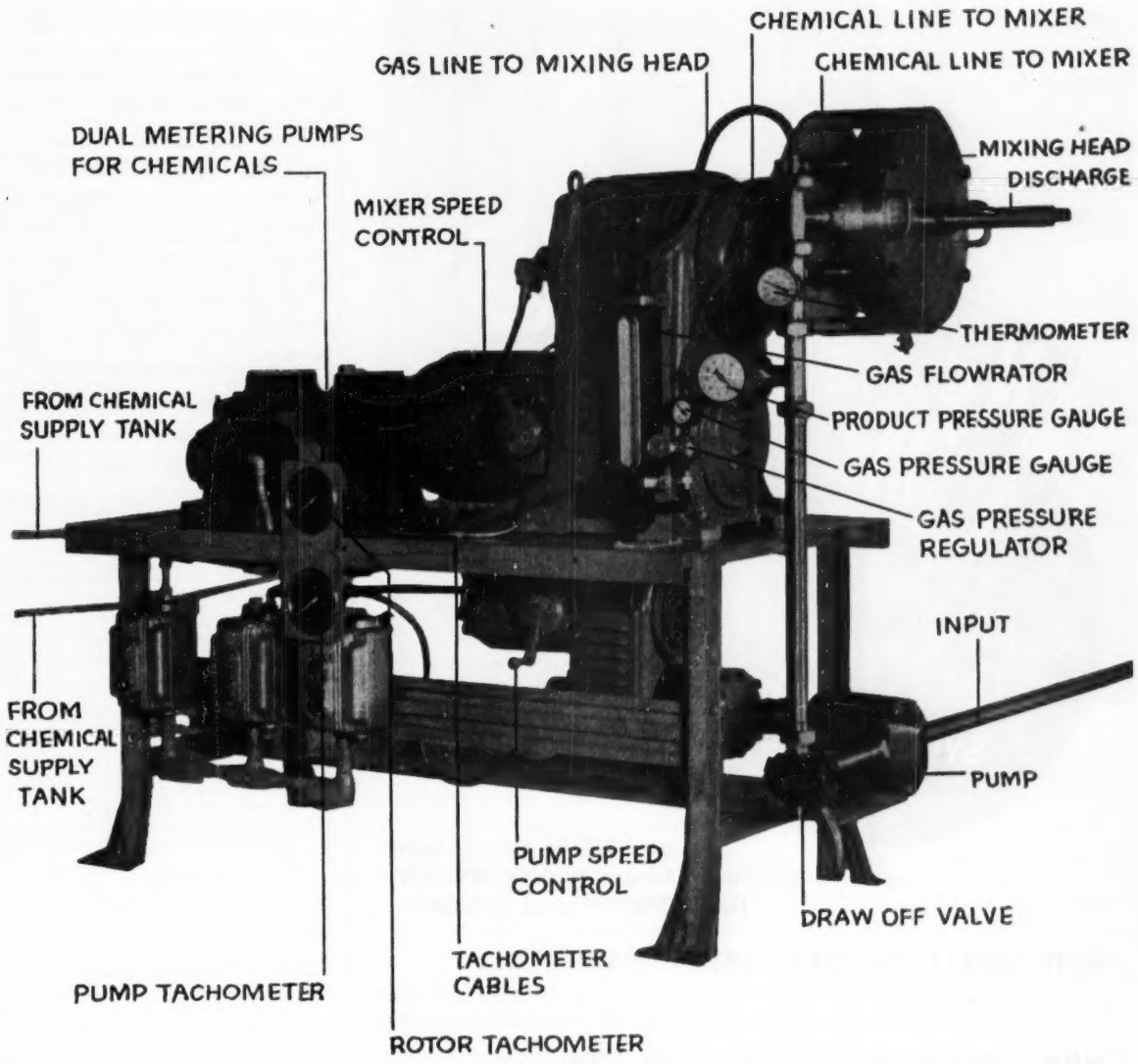

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The extent to which metal will corrode in atmosphere — or even whether it will corrode at all to any appreciable degree — is determined primarily by the moisture content of air. While deterioration at normal temperatures and humidities of less than 35% is so slow as to be almost negligible, the rate accelerates rapidly beyond a critical point of approximately 65%. This activity is intensified when such contaminants as hydrogen sulfide or sulfur dioxide are absorbed from industrial atmospheres. Impingement of solids, which tends to hold this acid film in contact with metal, localizes and further advances corrosive attack.

When exposure to atmosphere includes also exposure to sunlight and to the variables of weather, the situation becomes more complex. Such factors as the composition of metal and of the protective rust film that forms upon it, the length of time surfaces are wet, the extent to which they retain moisture, and whether they may be bared intermittently by heavy rainfall are influential in determining metal life.

An understanding of the mechanism of corrosion in all of its varied phases is an obvious requisite to prescribing methods of control. Thirty-five years' study and evaluation of industrial corrosion problems and the formulation of protective coatings to meet them has taught us something about corrosion and the ways in which it may be checked successfully.

We are ready to share that knowledge with you in an analysis of any metal-maintenance problem you feel requires the *different* approach of considered engineering judgment . . . to give you a recommendation you can be sure is technically correct and practically workable — for quality protective surfacing that is right for you because it is individually job-selected to meet your service specifications.

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how

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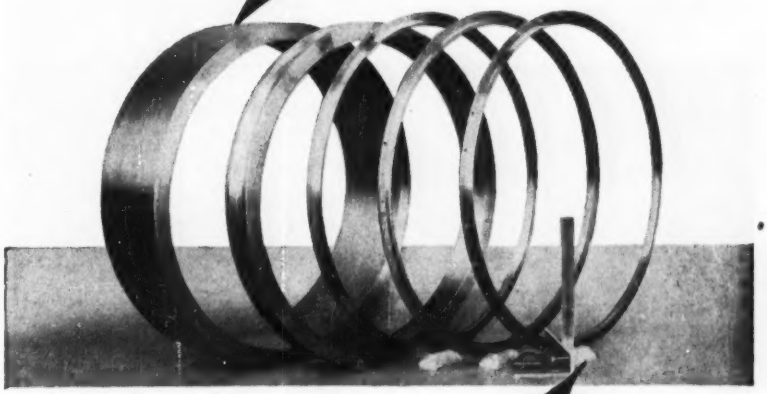

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—protects piping connections against:

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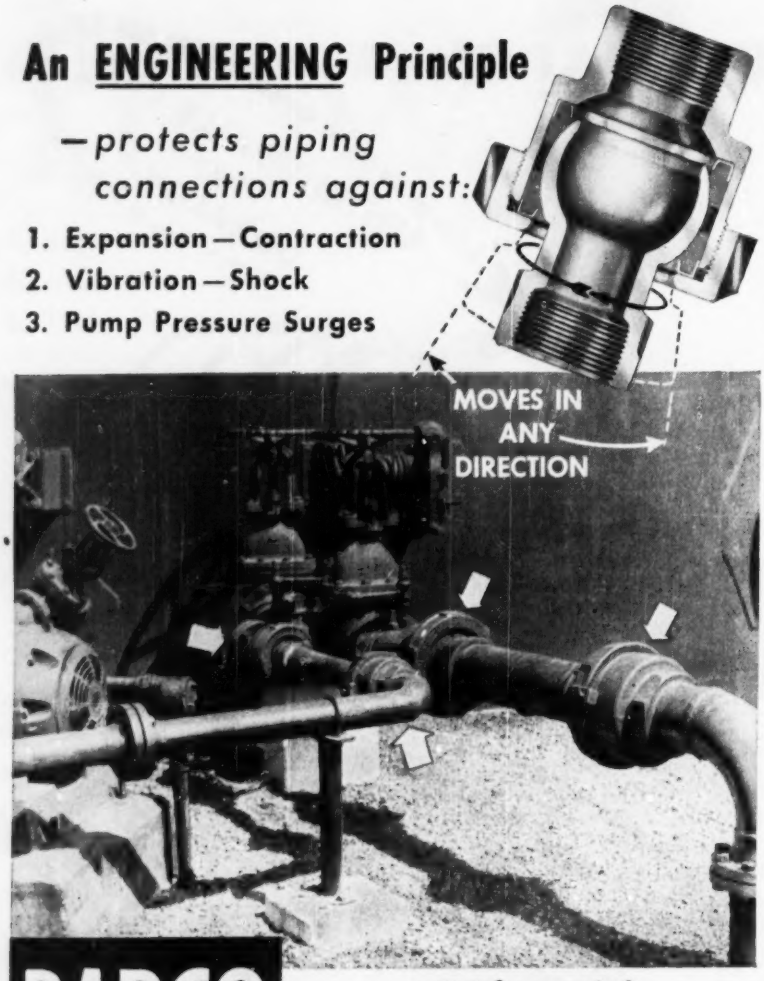
2. Vibration—Shock
3. Pump Pressure Surges



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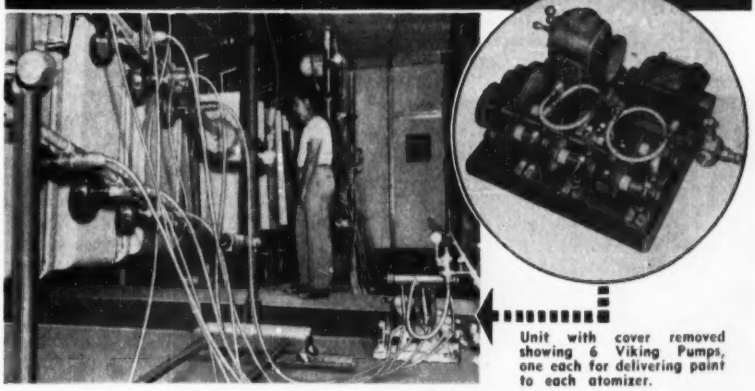
FOR EXACTING RANSBURG ELECTRO-SPRAY PROCESS



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The Answer: Viking Pumps were designed to meet Ransburg's requirements of very accurate and smooth delivery at varying and extremely slow speeds.

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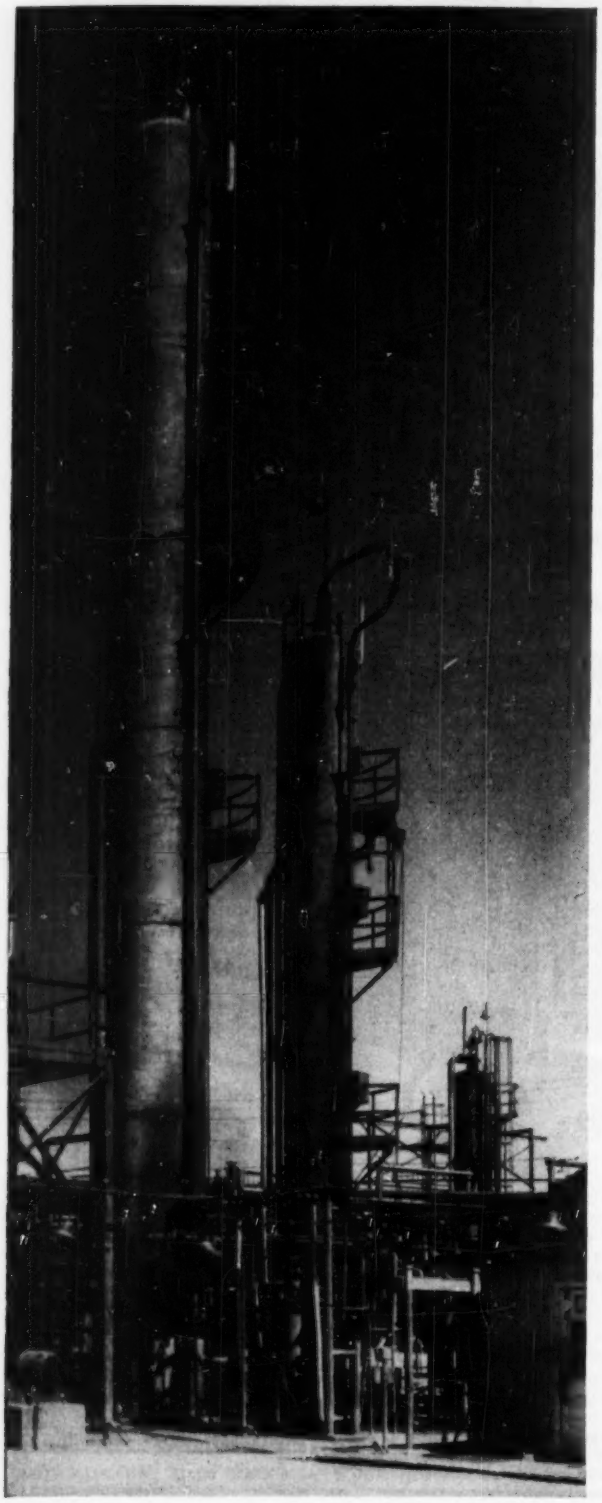

- **CHEMICALS**
- **EQUIPMENT**
- **SERVICES**
- **TECHNICAL LITERATURE**

What Reader Service Does for You

This department can serve you in four ways. It is a complete classified directory to equipment, chemicals and services offered in this issue of Chemical Engineering. It is a key to the Reader Service postcards (inside back cover) that will bring you free additional information on any of the listed items. It will keep you up-to-date with manufacturers' new technical literature. You can also use the Reader Service postcards to order reprints of Chemical Engineering features.

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The Reader Service postcard inside the back cover makes it easy to get more information on any of the chemicals, equipment or services listed here. The card has corresponding numbers for each of the key page numbers in this directory. Circle the numbers of the items you want; fill out the return address; mail the card to us. Answers will come direct to you from the companies. The letters, L, R, T, B, locate ads on the page: left, right, top, bottom. The letters a, b, c and A, B, C indicate first, second, third, etc., item in an ad or on a particular page.

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Chemicals

Acetonitrile 518A — Covers properties, constant-boiling mixtures, solubility for diverse materials, uses, suggested applications, & a bibliography. Technical Bulletin F-7501. Carbide & Carbon Chem. Co.

Acid Anhydrous, Hydrofluoric 42a — 40 p. book contains valuable information on hydrofluoric acid anhydrous. Provides useful data for those who now use HF, or for those contemplating its use. Harshaw Chem. Co.

Acid, Barbituric 518B — Includes data on properties (molecular weight, melting point, solubility), specifications (color, purity, etc.) & typical reactions, in Technical Bulletin. Kay-Fries Chem.

Acid, Diglycolic 518C — Economical dibasic acid offers interesting possibilities in numerous industrial applications. Includes specifications, properties, suggested uses, etc. E. I. du Pont de Nemours & Co.

Acid, Folic 518D — Folic acid of such purity & uniformity that it can be used for either oral or parenteral preparations. Specifications & tests, applications, etc. 36 p. N. Y. Quinine & Chem Wks.

Acid, Fumaric 140-1e — Includes such subjects as chemical reactions, fumaric acid in drying oils, in tall oil varnishes, in steam-set inks, & in polyester resins. Bulletin 0-115. Monsanto Chem. Co.

Acid, Phenylmercaptoacetic 518E — Valuable information on phenylmercaptoacetic acid—includes formula, physical properties, specifications, various uses, price schedule, bibliography, etc. Evans Chemetics.

Acids, Fatty 518F — In developing new line of hydrogenated fatty acids & glycerides, emphasis has been placed on: initial light color; resistance to discoloration under heat; etc. A. Gross & Co.

Acids, Organic 518G — 32 p. covers data on 8 organic acids sold in commercial quantities. Uses in many industries, physical properties, specifications, etc. Booklet F-4768. Carbide & Carbon Chem. Co.

Additives, Paint 518H — Company makes available a valuable file folder and ten bulletins describing case histories of Nuosperse 657, an improved wetting, dispersing and anti-settling agent. Nuodex Products Co.

Adhesives 518I — Offers new, illustrated reference, "Adhesives for Mylar," which covers a full range of adhesives for use with Mylar polyester film. Leaflet 130. Rubber and Asbestos Corp.

Alcohol, Acetylenic 518J — Alcohols, covering wide range of volatility, available in drum quantities, Technical Bulletin covers methyl butynol, methyl pentynol, dimethyl hexynol, etc. Air Reduction Chem. Co.

Alcohols, Fatty 518K — New Fact Sheet, "Fatty Alcohols for Industry," presenting typical reactions, may suggest the way you can use these versatile alcohols in your processing. Ethyl Corp.

Alumina Trihydrates 355b — Organic free alumina trihydrates can help improve your products and reduce costs. Provides complete information in brochure, "Reynolds Aluminum Chemicals." Reynolds Metals Co.

Ammonia, Cylinder 355c — "Guide to Use of Barrett Brand Cylinder Ammonia" shows most economical usage; contains chemical properties, handling, charts, etc. Nitrogen Div., Allied Chem. & Dye Corp.

Ammonia Leak Detector Kits 355d — Announces availability of useful ammonia leak detector kit. Handy kits are pocket size, and can be put to use over and over again. Nitrogen Div., Allied Chem. & Dye Corp.

Betaine Hydrochloride 518L — Technical Data Sheet offers essential data—describes suggested uses, formula, composition, melting point, appearance, solubility & grades available. Chemo Puro Mfg. Corp.

Brighteners, Optical 518M — Describes new optical brighteners—Safaritone White WNOA & Safaritone White C. Includes data on features & application—in addition to samples—of each. Hilton-Davis Chem. Co.

Bromantins 518N — Contains pertinent data on dibromantin and monobromantin—uses, storage and handling, packaging, availability and references—in Technical Bulletin. Arapahoe Chem.

N-Bromoacetamide 518O — Presents information on physical properties, reactions and uses, storage and handling, packaging, availability, in addition to a complete bibliography. Arapahoe Chem.

Calcium Hydride 518P — Supplies important data on physical properties, chemical properties and applications, handling and storage, available forms and references. Bulletin 201-D: Metal Hydrides.

Catalysts, Rhodium 56 — Simplify catalytic processing & effect savings for chemical & pharmaceutical manufacturers. Covers notes on their uses & a list of their most available forms. Baker & Co.

Cellulose Gum 518Q — Makes available a new technical booklet for the paper industry, describing the advantages of using Hercules CMC for gloss ink printing. Graphs, tables, etc. Hercules Powder Co.

Chemicals, Chromium 518R — Serves wide range of industries—pigment manufacturing, leather tanning, electroplating, metal cleaning & finishing, etc. Technical Bulletins. Mutual Chem. Co. of America.

Chemicals, Organic 518S — Booklet supplies important data on dispersing agents, polyvinyl acetate emulsions, high styrene copolymer resins, high styrene copolymer latices & plasticizers. Dewey & Almy Chem. Co.

Chemicals, Rubber 518T — Offers detailed information on Monex—general-purpose ultra accelerator. Includes chemical & physical properties, applications, recommendations for use, etc. Naugatuck Chem. Div.

Colors, Lime-Proof 518U — Issues Booklet showing samples of lime-proof colors available for mortar, cement, concrete and stucco. Included are the formula used and mixing instructions. J. Lee Smith & Co.

Copolymers, Vinyl Chloride 518V — New copolymers offer outstanding advantages of "built-in" plasticizer. Full information on preparation & properties in USDA Publication AIC-366. Agricultural Research Service.

Copper Sulphate Crystals 518W — New improved industrial crystals copper sulphate is readily adaptable to all types of solution equipment. Samples, specifications & detailed information available. Tennessee Corp.

Cosmetics, Sunscreen 337-8b — Data on new development in filters for ultraviolet light, especially useful for sunscreen cosmetics—(butyl carbityl) (6-propyl piperonyl) ether. U. S. Industrial Chem. Co.

Decylbutyl Phthalate 518X — Plasticizer has good low temperature properties & good heat & light stability. Recommended for extruded products (garden hose, gasketing, etc.) & sheeting applications. Naugatuck Chem. Div.

Dibutyl Sebacate 518Y — Highly efficient plasticizer widely used for low temperature applications in vinyl & rubber compounding. Pertinent data on properties & specifications. Naugatuck Chem. Div.

Di(2-ethylhexyl) Adipate 140-1f — Technical data on DOA, a primary plasticizer which imparts excellent low temperature flexibility to polyvinyl chloride resins & synthetic rubbers. Bulletin O-106. Monsanto Chem. Co.

1,2-Dimethoxyethane 518Z — Makes available a detailed Technical Bulletin on 1, 2-dimethoxyethane—includes formula, constants, properties and uses, proper handling, and bibliography. Arapahoe Chem.

Dinonyl Adipate 518AA — Dinonyl adipate is outstanding in its effectiveness as a low temperature, high efficiency plasticizer for vinyl compounds. Includes properties & specifications. Naugatuck Chem. Div.

Di(n-Octyl, n-Decyl) Phthalate 140-1g — Primary plasticizer imparts low volatility and excellent flexibility to finished compositions. Applications, properties, specifications, etc. Bulletin O-109. Monsanto Chem. Co.

Emulsifiers, Pesticide 518BB — Covers twelve formulations involving nine different pesticides that are adaptable for broad water-hardness conditions. Complete data in Technical Bulletin 41. Emulsol Corp.

Fungicides, Fruit 518CC — Effectively control apple scab & cherry leaf spot. Results in increased yields & better finish & in production of higher quality fruit. Data on glyodin. Carbide & Carbon Chem. Co.

Furfural 518DD — Offers versatility, high purity, low price . . . for processes & products involving use as selective solvent, resin ingredient, wetting agent, etc. Bulletin 204. Quaker Oats Co.

Glycerine 162 — "Glycerine—Preferred for Product Conditioning" outlines properties that make glycerine preferable in conditioning toilet goods & phamaceuticals, etc. Glycerine Producers' Assoc.

Hafnium Carbide 518EE — New data on properties. Literature references indicate hafnium carbide is a super-refractory compound . . . and is among the hardest materials known. Union Carbide and Carbon Corp.

Herbicides 140-1d	Covers use for weed control. Includes sections describing herbicidal action, soil life & application of Chloro—IPC—& a list of weeds it controls. Bulletin O-114. Monsanto Chem. Co.
Herbicides 519A	Superior formulations for cotton weed control. Repeated demonstrations show they are safest compounds available. Many promising uses. CIPC Bulletin. U. S. Industrial Chem. Co.
Herbicides 519B	Selective, systemic weed-killers particularly suited for killing many grassy & broadleaved weeds in cotton. Advantages & use in illustrated Ho-No-Mo Handbook. Spencer Chem. Co.
Hydrides, Metal 519C	Covers hydride process, titanium and zirconium (storage, handling, drying), special metals and alloy powders, calcium hydride, sodium hydride, sodium borohydride, etc. Metal Hydrides.
Hydrogen Peroxide 519D	Critical summary of most useful methods of assaying hydrogen peroxide solutions at all concentrations & under almost every conceivable condition. Bulletin 59. Buffalo Electro-Chem. Co.
Inhibitors, Plant-Growth 519E	Prevent development of suckers on tobacco . . . with no reduction in yield or adverse effect on quality. Features & directions for use in illustrated Booklet 22. Naugatuck Chem. Div.
Insecticide Sprays 519F	Outlines the characteristics and use of an insecticide spray which is non-residual and which may be used safely up to within 24 hours of picking or harvesting. Eston Chem. Div.
Insecticides 519G	Describes properties and usages of Malaphos—a remarkably safe, effective insecticide. Recommended for use on such crops as tomatoes, apples, pears, peas, etc. Eston Chem. Div.
Lead Tetra-Acetate 519H	Technical Bulletin features data on: formula, molecular weight, composition and appearance; reactions and uses; precautions and handling; correct storage; etc. Arapahoe Chem.
Lithium 519I	Offers addition of high-grade lithium ores—Lepidolite (3.5% minimum Li_2O) & Petalite . . . to meet growing demands of industry. Technical data. American Potash & Chem. Corp.
Magnesias 519J	Offers industry's most complete line of magnesias for broadest range of application. Covers descriptions, properties, uses of over a dozen different grades. Westvaco Chem. Div.
Methanol 519K	Offer important uses—intermediate for formaldehyde & methyl chloride; fuel for heating insulated railroad cars; anti-freeze for gasoline; etc. F-8141. Carbide & Carbon Chem. Co.
Methyl Toluene Sulfonate 140-1a	Company offers Data Sheet with information on methyl toluene sulfonate—a mild methylating agent used primarily in the manufacture of pharmaceuticals & dyes. Monsanto Chem. Co.
Monomers, Acrylate & Methacrylate 519L	Ability of copolymers containing acrylates or methacrylates to resist aging is superior to that of corresponding acrylic-free polymers. Details in 38 p. Booklet. Rohm & Haas Co.
Nitrogen Products 519M	Covers new plant, in Memphis, Tenn., designed to produce 72,000 tons of nitrogen annually, in the form of urea and anhydrous ammonia. 20 p. illustrated Booklet. Grace Chem. Co.
Nitrogen Solutions 519N	60 p. includes valuable data on ammoniating liquids, ammoniation & recommended handling procedure. Complete with numerous illustrations, tables, graphs. Spencer Chem. Co.
Petro-chemicals 360a	New petrochemical plant now making high-purity aromatics—nitration benzene, nitration toluene, ten degree xylene. Pertinent information in technical bulletins. Sun Oil Co.
Phosphorus Products 519O	Quality assured by rigid control from mines to finished product . . . service assured by large-scale production and ample phosphate rock reserves. American Agricultural Chem. Co.
Phthalic Anhydride 519P	Covers important data on phthalic anhydride in detailed "Aero Phthalic Anhydride, Properties and Methods of Handling." Manufacturers Chem. Dept., American Cyanamid Co.
Pigments, Iron Oxide 446	Reduce grinding & dispersing time in paints & allied products as much as 75%. Physical & chemical specifications & suggested applications. VVF Tech Report. C. K. Williams & Co.
Plasticizers 519Q	Data on dimethyl phthalate, diethyl phthalate, triacetin, tributyrin, di-isobutyl adipate, etc. Includes specifications, properties and typical uses. Eastman Chemical Products.
Plasticizers, Azelate 519R	Direct comparison proves advantage of azelates over other aliphatic diester plasticizers. Presents a descriptive Booklet covering all Plastolein plasticizers. Emery Industries.
Plasticizers, Citrate 309	Offers group of 4 citrate plasticizers . . . each with special properties that determine its use. Feature an extremely low order of toxicity. Technical Bulletin 31. Chas. Pfizer & Co.
Plasticizers, Nontoxic 140-1b	Effective plasticizer can be used in vinyl film & sheeting, in packaging materials & adhesives, in plastisols & organosols. Data in Santicizer 141 Bulletin. Monsanto Chem. Co.
Polystyrene Beads 519S	Furnishes detailed information on expendable polystyrene beads and polystyrene foam. Includes advantages, properties, applications, etc. Technical Bulletin C-4-200-T. Koppers Co.
Potassium Acetate 519T	Long known for its high purity . . . now available in a special new spray-dried form which has improved physical characteristics. Offers complete details. Baker & Adamson Products.
Preservatives, Emulsion Paint 519U	Provide greater protection for emulsion paints . . . at a lower cost. Covers data on performance, savings, handling, toxicity, efflorescence, tests, etc. Scientific Oil Compounding Co.
Pyridine 519V	Describes uses & properties, & includes data on company's new recovery service which enables users to appreciably reduce pyridine costs. Pittsburgh Coke & Chem. Co., Coal Chem. Div.
Resins, 519W	Data on basic advantages of Epon resin-based formulations—excellent adhesion, resistance to abrasion & impact, etc. "Epon Resins for Surface Coatings." Shell Chem. Corp.
Resins 519X	Includes data concerning properties of full line of coumarone-indene resins, modified coumarone-indene resins, oxidizing resins, etc. Covers latest prices. Neville Chem. Co.
Resins Alkyd 337-8a	Outside house paints containing new alkyd resin offer cleaner, whiter surfaces after exposure & improved over-all durability. Detailed information. U. S. Industrial Chem. Co.
Resins, Electrical Insulation 519Y	Technical data on new epoxy type electrical insulation resin. In addition to long pot life & quick cure, it features excellent electrical & physical properties. Minnesota Mining & Mfg.
Resins, Polyvinyl Chloride 519Z	Data on high molecular weight polyvinyl chloride resin which can readily be dispersed in plasticizer to form a plastisol paste. Sales Service Bulletin 7. Firestone Plastics Co.
Resins, Synthetic 519AA	Versatile synthetic resin . . . a favorite material in hundreds of industrial plants. Bulletin covers features, physical & chemical properties, etc. Pennsylvania Industrial Chem. Corp.
Riboflavin 519BB	U.S.P. riboflavin types (Regular) for dry preparations such as tablets & capsules not to be dissolved in mouth & (Solutions) for solutions of low concentration. Hoffman-La Roche.
Sodium Dispersions 519CC	Properties, uses, availability, preparation, formulations, handling procedures, analysis, typical methods for use, etc. in illustrated 30 p. booklet. U. S. Industrial Chem. Co.
Sodium Hydride 519DD	Sodium hydride is a powerful drying agent for hydrocarbons, ether and amines. Fact Sheet contains detailed data on its specific uses, preparation and properties. Ethyl Corp.
Sodium Lauryl Sulfate 519EE	Form of small extruded needles . . . eliminates sneezing & sniffing often encountered in a plant when working with a powder form. Has a greater bulk density. Aceto Chem. Co.
Sorbitol 519FF	Describes sorbitol's characteristics and functions in food preparations. Includes data on nutritive value and use in special dietary foods. Food Industry Div., Atlas Powder Co.
Succinonitrile 140-1c	Will undergo typical reactions of the nitrile group. Can be readily reduced in high yields to pyrrolidine. Information in Succinonitrile Data Sheet. Monsanto Chem. Co.
Surface Active Agents 519GG	Surface active agents give water a thinner skin like that of organic liquids. Details in "Leak Testing with Aerosol OT." Manufacturers Chem. Dept., American Cyanamid Co.
Tetrine, Iron 519HH	Iron Tetrine and related Ferralkine products cure and prevent agricultural crop iron deficiencies. Description of products and their uses in new Bulletin. Glyco Products Co.
Thiophosphoryl Chloride 519II	Issues Technical Bulletin covering description, typical analysis, properties, suggested uses, typical reactions, toxicity, availability and storage. Westvaco Chem. Div.
Wax, High Melting Point 519JJ	Describes fatty amide high melting point wax used to opacify shampoos, raise the melting point of glyceride & paraffin oils, etc. in new Technical Bulletin 40. Emulsol Corp.
Waxes, Microcrystalline 519KK	Company provides fully detailed information on microcrystalline and synthetic waxes, in various technical booklets, bulletins and price lists. Petrolite Corp., Wax Div.
Wetting Agents 129	If you require the basic raw material, wetting agents in intermediate form or finished products . . . company offers highest quality & uniformity. Technical Bulletins. Oronite Chem. Co.

Process Equipment

Autoclave-Reactors 55 — Offers engineering knowledge, fabricating skill, facilities . . . for greater reliability. In any capacity, for any pressure, temperature or reaction. Catalog 2413. Blaw-Knox Co.

Blast Cleaning Equipment 520A — 28 p. on accessories & supplies available for use with blast cleaning equipment. Accessories include: helmets, gloves, hoses, nozzles, aprons, etc. Bulletin 300C. Pangborn Corp.

Centrifuges 127 — Proven, economical means of continuously handling slurries—with wide variation in solids concentration (Bulletin 1254). For pilot plant use (Bulletin 1275). Sharples Corp.

Centrifuges 69 — Offer advantages with regard to many important factors: initial & maintenance costs; production capacity; ease of cleaning; versatility; etc. Booklet 6-RC-3. Heyl & Patterson.

Chemical Equipment 412 — Data on a wide range of types & sizes of acid & alkali-proof chemical equipment. Includes pipe, ductwork, tanks, kettles, jars, filters, towers, etc. Bulletin 11. Maurice A. Knight.

Chillers, Liquid 520B — Makes available literature on a new and revolutionary liquid chiller with capacity from 2 to 200. Includes information on design and advantages. Bulletin LC-1. Kennard Corp.

Chillers, Water 107 — Chilled water for blending, mixing, external cooling or wherever required in processing operations. Features & engineering suggestions—Catalog 101. Patterson-Kelley Co.

Collectors BL470 — For efficient removal of air-borne contamination (dust, fumes, vapors, acid gases & odors) & recovery of product thru multiple washing action. Bulletin 610. Claude B. Schneible Co.

Columns, Fractionating 357c — Offer advantages in solving fractionating & absorption problems. No corrosion, no contamination. In 4" & 6" sizes with any number of plates. Data Sheet. Corning Glass Wks.

Converters, Dry Ice L449 — Dry ice converters are A.S.M.E. code pressure vessels especially adapted to charging with full 50-lb. cakes of solid CO_2. Feature no operating costs. Dry Ice Converter Corp.

Demineralizers M452 — Variety of mono- & multi-column models (flow rates from 10 to 10,000 gph). Equipped with regenerant tanks & necessary gages, flow meter, etc. Offer Catalog. Penfield Mfg. Co.

Dryers 92 — Drying air, other gases and organic liquids to precise, low conditions meet needs of industry and science. Covers description of function and operation. Pittsburgh Lectrodryer Corp.

Dryers 426 — Leader in industrial drying equipment and processing machinery offers pertinent information on tray dryers, truck dryers, spray drying, etc. Bulletin 390. Proctor & Schwartz.

Dryers, Rotary TL474 — For materials or products that are critical to high temperatures, solve your drying problems with a rotary warm air dryer. Offers detailed Catalog. Davenport Mach. & Foundry Co.

Drying, Vacuum 350 — Offers informative brochure, "Vacuum Drying," with data on the techniques of moisture removal from chemicals, pharmaceuticals and other industrial products. F. J. Stokes Mach. Co.

Dust Collectors 317 — Offer high efficiency, economical operation, dependable performance, economy of space required for installation. 28 p. American Wheelabrator & Equipment Corp.

Dust Collectors 409 — Describes dust control & its advantages. Large reclamation savings result from effective trapping of valuable chemical dusts. Maintenance costs lowered. Bulletin 909-A. Pangborn Corp.

Dust Collectors 520C — Reverse jet fabric type for applications where extremely fine particles are involved or where material must be collected in dry state for reclaiming. Bulletin 279. American Air Filter Co.

Dust Collectors 520D — Data on how to control dust in manufacture of paint. Provides case histories of four different companies—fully illustrated. Bulletin 422. American Wheelabrator & Equipment Corp.

Dust Control 520E — Provides data on dust & fume control systems. Recommended for collection of fumes from dryers of all types, electric steel furnaces, etc. Illustrated. Mechanical Industries.

Dust Control L460 — Valuable data relating to scope of dust problem or collection equipment requirements found in new manual. "A Simplified Test Method for Dust Control Determination." Dustex Corp.

Ejectors, Three-Stage 328 — Feature double purpose—to pull the vacuum required in processing a chemical product . . . to recover a valuable solvent used in the process, & return it for further use. Elliott Co.

Eliminators, Mist 402 — Effectively & economically control liquid entrainment resulting from processing operations which involve handling of liquids & gases together. Offers Catalog. Metal Textile Corp.

Evaporators 169 — Vertical rapid concentration evaporators offer high rates of evaporation, maximum recovery of solids, with simple, easy operation. Details in Catalog. Buflovak Equipment Div.

Extractors, Centrifugal 520F — Countercurrent extractor for systems using 2 immiscible liquids. Includes general description, principle of operation, advantages, etc. in illustrated Bulletin 102. Sharples Corp.

Filters 101 — Makes available 4 filter catalogs—Industrial, Aviation, Automotive and Fleet. Describes the many types of filters for various industries. Illustrated. Purolator Products.

Filters, Air 319 — "Dry" type viscous air filter that maintains its efficiency automatically up to one year with one roll of low-cost Amer-glas media. Bulletin 248. American Air Filter Co.

Filters, Continuous Vacuum 520G — Furnishes valuable information on continuous vacuum filters and dryers for the chemical and metallurgical process industries, in illustrated Bulletin F2012. Eimco Corp.

Filters, Diatomite 520H — How filtration of water or other liquids for industrial use can be obtained simply & efficiently by means of diatomite filters. Bulletin WC-115. Graver Water Conditioning Co.

Filters, Pressure 520I — Feature low first cost, low element cost, no flow restrictions, internal pressure backwashing. Includes data on design and applications in illustrated Bulletin F2031. Eimco Corp.

Filters, Pressure Leaf 245 — For flow rates 2 to 5 times greater than cloth covered presses; positive removal of all suspended solids to desired degree of clarity; etc. Catalog NC-1-53. Niagara Filters Div.

Generators, Inert Gas 76 — Help meet purging or blanketing problems. Complete with the latest fire checks and safety devices. Full details and technical information in Bulletin 1-10. C. M. Kemp Mfg. Co.

Grinding & Blending Systems 8 — Integrated system features savings in time & money in combined functions of grinding, blending & dust control. Results in greatly increased production. Pulverizing Machy. Co.

Homogenizer-Disperser 520J — Emulsifies . . . disperses . . . grinds . . . homogenizes—improves your product, speeds up production. Covers operation & features in new, 8 p. illustrated Bulletin. Tri-Homo Corp.

Kettles TR458 — Available for every processing need. Descriptive bulletins cover kettles—where corrosion-resistant equipment is needed. Kettles made to A.S.M.E. code. Lee Metal Products Co.

Kilns, Rotary BL468c — Literature furnished which describes company product line. Includes data on continuous rotary kilns, dryers (single & double shell) & coolers. Bulletin 16-D-11. Hardinge Co.

Mills, Grinding 49 — For wet or dry, coarse or fine grinding. Assures a uniform product of desired fineness. Improved design and construction features in Bulletin 8121. Traylor Engrg. & Mfg. Co.

Mixers BR473 — Homo-Mixer built & operates on an entirely new principle. Draws only from the bottom of the tank with no vortex. Covers details in Catalog 402. Admiral Tool & Die Co.

Mixers 95 — Meet requirements for heavy duty kneading and mixing. Feature air seal type stuffing boxes, new dumping mechanism, heavy duty bearings, etc. Details in Bulletin 600. J. H. Day Co.

Mixers 394 — Mixers meet tremendous variety of fluid mixing needs. Includes data on side entering mixers, top entering mixers, turbine mixers, etc. in Fluid Mixing Catalogs. Eastern Industries.

Mixers, Laboratory 243b — Laboratory mixers: electric motor driven, direct drive, variable speed & geared models. Air motor driven models also available. Details in Bulletin DH-50. Mixing Equipment Co.

Mixers, Side Entering 243f — Covers detailed information on features, typical applications, mechanical design, maintenance, shaft seals, methods of installation, etc. Catalog B-104. Mixing Equipment Co.

Mixers, Top Entering 243e — Data on top entering mixers (propeller type) . . . for closed tanks, pressure & vacuum . . . for open & loose-covered tanks. Illustrated. Catalog B-103. Mixing Equipment Co.

Presses, Filter 416a — Provide numerous features: low first cost & operating cost; long service life . . . high resale value; operate to 1000 psi at high or low temperatures; etc. T. Shriver & Co.

Processing Apparatus 2 — 32 p. describes various continuous processing systems. Advantages of Votator heat-transfer apparatus for heating, crystallizing, controlling heat of reaction, etc. Girdler Co.

Processing Equipment, Chemical 521A	Illustrated Folder contains numerous bulletins & technical data on chemical & industrial processing equipment. Covers agitators, dryers, pumps, etc. Denver Equipment Co.
Propellers TL466	Smooth, vibrationless propeller for stirring, mixing, aerating, pumping, etc. Balanced to avoid whip & strain on shafts. Wide variety of metals & sizes up to 60". Michigan Wheel Co.
Rubber Equipment, Hard 299	Synthetic hard rubber for chemical equipment offers chemical resistance plus economy for high temperature applications. Data in Bulletin 96-A. Ace Rubber & Plastic Products.
Scrubbers, Gas 78	Installations successfully handle difficult gas scrubbing problems. Help stop air pollution and recover valuable materials. World-wide usage. Bulletin M-102. Chemical Construction Corp.
Selectors, Agitator 521B	Makes available pocket sized, sturdy "Capaci-Dial" selector which automatically tells the best Pheumix agitator for each liquid batch mixing problem. Eclipse Air Brush Co.
Softeners, Water 521C	Offer lower cost, easy installation, minimum of piping requirements, ease of operation, low chemical costs. Complete information in Publication 4505-A. Cochrane Corp.
Wire Cloth BR460	Makes wire cloth & filter cloth in all meshes & metals; filter leaves & screens, discs, strainers, baskets, etc. Offers details in Catalog 50. Multi-Metal Wire Cloth Co.

Pumps, Blowers, Compressors

Compressors, Centrifugal 327	Offers complete line of centrifugals for gas compression and refrigeration—up to 10,000 hp in a single unit. Details in "Centrifugal Compressors for Industry." Carrier Corp.
Compressors, Centrifugal Recycle 521D	Offer many features: low capital investment; low maintenance cost; smaller physical dimensions; oil free compression; high efficiencies; etc. Illustrated. Sawyer Bailey Corp.
Fans 9	Multi-blade aluminum fans are engineered specially for cooling tower application . . . and operate more smoothly, quietly, efficiently. Details in Bulletin CF-54. Marley Co.
Pumps 53	Company makes available complete performance data on the Chempump—a new concept in pump design that completely eliminates all seals and stuffing boxes. Chempump Corp.
Pumps 344	Efficiently, economically solve hard-to-handle fluid problems—hot or cold, acidic or alkaline, viscous or corrosive, clear or filled with suspended solids. De Laval Steam Turbine Co.
Pumps, Centrifugal 387a	Corrosion-resistant products for fluid handling include buna N & natural hard rubber centrifugal pumps, valves, pipe & fittings. Bulletin BHR. Vanton Pump & Equipment Corp.
Pumps, Centrifugal 22-3e	Impervious graphite pumps feature mechanical seal with enclosed coolant, rugged type SN armored connections, interchangeability of parts, etc. Catalog S-7250. National Carbon Co.
Pumps, Centrifugal 407	Handle corrosive liquids. Now available in 8 different materials. Data on these new materials, performance curves, specifications & dimensions. Bulletin 725.3. Goulds Pumps.
Pumps, Centrifugal 457	Meet most corrosion-resistant pump needs. Features include wide choice of seal types & design & manufacture that exceeds 3A sanitary standards. Catalog 253. Tri-Clover Div.
Pumps, Chemical 308B	Contains original approach to NPSH (net positive suction head), together with data on use of this concept in selecting turbine pumps for chemical service. Section 100. Roy E. Roth Co.
Pumps, Controlled Volume 521E	Illustrated, 24 p. covers line of Pulsafeeder diaphragm-type controlled volume pumps . . . for handling corrosive & non-corrosive liquid chemicals. Bulletin 440. Lapp Insulator Co.
Pumps, Controlled Volume 84	Mersemetric pumps—the new controlled volume pumps for submerged operation—feature no leakage to atmosphere, no diaphragm, no contamination. Bulletin 1153-B. Milton Roy Co.
Pumps, Motor 521F	Makes available a very interesting & informative Booklet dealing with the selection of the proper motor pump for any specific job. Illustrated Form 7123. Ingersoll-Rand Co.
Pumps, Oil Diffusion 521G	Complete physical dimensions, operating data, & performance curves for each type MCF high vacuum oil diffusion pumps. Illustrated Data Sheet 6-55. Consolidated Vacuum Corp.
Pumps, Plastic 387b	Handle highly corrosive fluids & abrasive slurries. Unique design eliminates stuffing boxes, shaft seals, gaskets, check valves. Bulletin VP. Vanton Pump & Equipment Corp.
Pumps, Process 35	In wide choice of materials . . . to handle many types of abrasive or corrosive material at temperatures up to 250F. Feature no leakage. Bulletin 08B6615. Allis-Chalmers Mfg. Co.
Pumps, Propeller 403	Well adapted for circulating service because of simplicity, high efficiency and low first cost. Includes a summary of acid and chemical pump data in Bulletin 203-6. Lawrence Pumps.
Pumps, Proportioning TR481	3 pumps in one—7,500, 15,000 or 30,000 psi working pressure made possible by interchange of piston & cylinder assemblies in same pump frame. No. 4061-A. American Instrument Co.
Pumps, Sanitary 339	Positive displacement sanitary pumps for product protection. Feature longer life & more efficient performance at low maintenance cost. Offer Instruction Handbook. Waukesha Foundry Co.
Pumps, Vacuum 257	Information on company line of 13 single stage & compound vacuum pump models . . . the largest, most versatile pump line on the market. Bulletin V-51B. Kinney Mfg. Div.
Pumps, Vacuum 521H	Rotary valve, high efficiency, dry vacuum pumps . . . especially adapted for use where it is essential to maintain a high vacuum. Details in Catalog 200-D. J. P. Devine Mfg. Co.
Pumps, Vertical T448	Designed to handle molten sulphur. Steam jacketed discharge pipe keeps molten materials from solidifying. Work efficiently at slow speed of 1750 rpm. Bulletin V-837. Taber Pump Co.
Pumps, Vertical Turbine 396	Covers company line of vertical turbine pumps. Includes complete data about applications in air conditioning systems and many other uses. Illustrated Bulletin 4700. Deming Co.

Instruments & Controls

Actuators, Valve TR460	For power operation of gate, plug diaphragm, and other line valves. They are pneumatically or hydraulically operated for direct or remote control. Bulletin 3000. Ledeen Mfg. Co.
Analyzers 285a	For the process plant. Highly stable & sensitive. Suitable where there is considerable interference from stream components. Data in descriptive Bulletin. Perkin-Elmer Corp.
Analyzers, Hydrogen 521I	Data on hydrogen analyzers for the continuous analysis, control and recording of molecular hydrogen. Covers description, features and operation. Bulletin 301. Taller & Cooper.
Analyzers, Multi-Component 285b	For the pilot plant. Continuously record the concentration of up to six components in a pilot process stream on a six-minute cycle. Details in Bulletin. Perkin-Elmer Corp.
Cameras 521J	For industrial television installations where a smaller camera having high resolution & using lower light levels is desirable. Bulletin 1136A. Diamond Power Specialty Corp.
Controllers 521K	Eliminate start-up "overshoot" in batch processes. Diagrams show instrument circuitry and comparative responses of various control actions. Report TI 29-B-52a. Foxboro Co.
Controls, Thermal 73B	Help solve temperature control problems which involve heat, humidity, radiant heat, pressure and other variables. Offers complete information on Thermoswitch units. Fenwal, Inc.
Converters, Thermocouple 521L	Describes autronic thermocouple converter in detail and gives data on principles of operation. Covers mechanical and electronic specifications, ranges, etc. Swartwout Co.
Cryostats, Helium, Collins 521M	Basic instrument for cryogenic research liquefies helium & maintains a test chamber from normal room temperature to within 2 degrees of absolute zero. Arthur D. Little.
Detectors, Carbon Monoxide 521N	Designed for efficient, economical operation . . . safeguard against one of the deadliest of industrial hazards—odorless, colorless carbon monoxide. Illustrated. Taller & Cooper.
Gages 435	For pressure, vacuum or compound service. No gears or teeth to wear out. Cam wiping action keeps contact points clean & smooth. Details in Catalog G-2. Helicoid Gage Div.
Gages, Liquid Level TR473	Describes liquid level gages: reflex; thru vision; tubular. Standard equipment in leading refineries & industrial plants all over the world. Offers Catalog. Strahman Valves.
Gages, Tank TL447	Information on 100% automatic tank gages for gaging liquids of all kinds. Gages are approved by the Underwriters' Laboratories. Offers complete details. Liquidometer Corp.
Gages, Ultrasonic-Resonance 521O	Presents illustrated Folder listing specifications and applications for ultrasonic-resonance thickness gages for measuring thickness from one side. Branson Instruments.

All Up-to-Date Catalogs and Bulletins Upon Request.

Generators, Ultrasonic 522A — Offers detailed information on ultrasonic generators . . . for faster, cheaper, more thorough metal cleaning. Includes data on operation, specifications, etc. Branson Instruments.

Indicators, Oxygen 351 — Compact, accurate instruments designed to continuously measure the oxygen content of industrial atmospheres. Bulletin covers features & applications. Mine Safety Appliances Co.

Indicators, Temperature L458 — Compact, complete in precision design & workmanship . . . rugged instrument assures highest standards of speed, accuracy, dependability. Bulletin 4257. Illinois Testing Labs.

Instruments, Testing 522B — For economical, safe testing & calibrating of current actuated & protective devices . . . motor starter overload relays, air circuit breakers, etc. Fully detailed. Multi-Amp Corp.

Load Measuring Elements 52 — For tricky load measurement problems-measuring tension on conveyor belt, thrust on a bearing, weight of solids or corrosive liquids in a tank. Bulletin 98232. Taylor Instrument.

Meters 171 — Measure, indicate and total flow of corrosive and hard-to-meter liquids without the use of weigh tanks, orifice plates, or gage sticks. Details in Pub. 53-766-38. Hays Corp.

Meters 79 — For continuous, accurate weighing of bulk material passing over conveyor belts. Respond accurately to rapid load variations. Details in Bulletin 550-H4A. Builders-Providence.

Meters 91 — Ideal for measuring liquids entering into foods and pharmaceuticals—also chemicals and corrosive liquors. Construction of stainless steel. Bulletin OG-403. Rockwell Mfg. Co.

Meters, Flow BR468 — Feature only 3 moving parts—no breakdown due to complicated gears and mechanism. Indicate flow within 3% absolute accuracy, even with pulsating flow. Henszey Co.

Meters, pH 302E — Announces a compact, panel-mounted automatic pH meter which features quick servicing and versatility. Complete information in illustrated Bulletin 342-14. Beckman Instruments.

Recorders 27a — Detailed data on a portable recorder built to full-size instrument reliability. Also covers recording psychrometers & hygrometers. Catalog 400. Gotham Instruments Div.

Spectrophotometers 522C — Double beam infrared spectrophotometer—fastest, most efficient instrument commercially available for recording of large numbers of spectra. Bulletin 104. Perkin-Elmer Corp.

Spectrophotometers, Flame 522D — Makes available descriptive literature—an introductory folder on flame analysis with Beckman Models B & DU flame spectrophotometers. Bulletin 325. Beckman Instruments.

Temperature Monitoring Systems 419 — Makes available detailed information on Signalarm—a temperature monitoring system composed of well-tested, standardized units—in Bulletin 70-E. Thermo Elec. Co.

Thermocouples 522E — Covers full line of products: bare wire thermocouple glands, packing glands, protection tubes, quick disconnect thermocouples, etc. 16 p. illustrated Catalog 1530. Conax Corp.

Transmission, Instruments, Pneumatic 102 — Pneumatic transmission instruments measure, indicate, record, & control pressure, temperature, vacuum, flow, differential pressure & liquid level. Detailed Bulletin. Bristol Co.

Transmitters, Pneumatic 88 — 36 p. cover transmitters for measuring flow, pressure, level, density. Offer longer life, less maintenance, continuous, accurate operation. Data Book 1004. Republic Flow Meters Co.

Transmitters, Pneumatic 522F — Combines Penn pneumatic transmitter with a high quality pressure gage for remote indicating, recording or controlling of pressures. Bulletin 1025. Penn Industrial Instrument Corp.

Transmitters, Pressure 304C — Used with pneumatically-operated instruments in measuring pressure of liquids & gases—or depth, weight or volume of liquids—in vented & pressurized tanks. King Engrg Corp.

Tubes, Venturi, Miniature 522G — For measurement of fluids, either gaseous or liquid, in quantities ordinarily considered too low for application of a normal size Venturi or orifice. Simplex Valve & Meter Co.

Viscometers L473 — Standard instruments for nearly every type of viscosity determination problem. Feature high accuracy & sensitivity. Details on all models & accessories. Brookfield Engrg. Labs.

Weighing Systems, Electrical 280-1a — Measure batch ingredients accurately . . . automatically. Data Sheet 10.18-1a, "Unit Measuring Systems with Baldwin Electric Strain Gages." Minneapolis-Honeywell Regulator Co.

Construction Materials

Alloys, Hardfacing 383 — Superior resistance to corrosive agents, abrasion and galling. Spraywelding method of application quick and economical. Data in Hard-Facing Manual. Wall Colmonoy Corp.

Alloys, Nickel 522H — Offers valuable data on Monel. Strong, tough alloy handles acids, alkalies & salts with minimum of corrosion or contamination. Technical Bulletin T-5. International Nickel Co.

Cements 404 — Basic types of corrosion-proof cements & constructions. Cement shown in its relationship to temperature & the broad classes of corrosives handled. Atlas Mineral Products Co.

Cements 522I — Offer outstanding advantages—acid & waterproof . . . abrasive & heat-resistant . . . chemically setting etc. Data on mixing in illustrated Bulletin. Robinson Clay Product Co.

Cements, Furan M451 — Data on a basically different furfural-ketone resin cement. Offers advantages common to all furan-type cements plus 6 important points of superiority. Pennsylvania Salt Mfg. Co.

Cements, Resinous Bonding 522J — Valuable data on new acid-proof, alkali-proof and solvent-proof synthetic resinous bonding cement which adds years to life of brick and tile structures. Illustrated. Cellcote Co.

Electric Furnace Products 294-5 — Basic materials for solving processing problems—aluminum oxide, silicon carbide, boron carbide, fused stabilized zirconia, boron nitride, etc. Data on uses. 22 p. Norton Co.

Fabrication, Metal 94 — "Facilities and Products" with data & photos which show why company can turn out—at low cost—specialized heavy equipment for chemical plants. Newport News Shipbuilding.

Fabrication, Metal 408 — Manufactures metal products for many industrial uses . . . from complete carbon-black plants to steel conveyor boxes. Designs, engineers & fabricates to specific needs. Boardman Co.

Fabrication, Pressure Vessels 331 — Set up to fabricate pressure vessels of all kinds in full compliance with ASME and other code requirements. Makes available descriptive literature. Downingtown Iron Wks.

Insulation, Cellular Glass 67a — Aluminum-jacketed Foamglas offers valuable features: faster, cheaper application; beautiful low-cost finish; less maintenance; extra insulation. Pittsburgh Corning Corp.

Insulation, Pipe 381 — Covers new lightweight one-piece pipe insulation. Includes data on application, properties, selection help, sizes & thicknesses available, etc. Illustrated. Baldwin-Hill Co.

Insulation, Pipe 67b — Advantages of Foamglas for pipe temperatures between —300° and +800°F. Includes physical properties, specifications, installation data, etc. Illustrated. Pittsburgh Corning Corp.

Insulation, Pipe 77 — Insulation that fuses itself into lifetime protection for hot underground pipes. Water, corrosion, root acid/alkali—proof. Economical, easy to use. American Gilsonite Co.

Insulation, 67c — Covers physical properties of Foamglas, sizes & shapes available & recommended thicknesses required for temperatures ranging from —50° to 800°F. Illustrated. Pittsburgh Corning Corp.

Lead Products 133 — For efficient control of corrosives. Provides all common mill shapes, sizes & forms . . . sheet, pipe, fittings, valves, etc. New Booklet on "Chemical Lead Products." National Lead Co.

Paints, Aluminum 434 — Feature added protection, long life, greater hiding capacity, greater light reflectivity, etc. Ideas for usage in new Aluminum Painting Handbook. Metals Disintegrating Co.

Plastics 104 — Tygon plastic offers superior flexibility & corrosion-resistance. Technical data on use of Tygon in its various forms, in convenient reference binder. U. S. Stoneware Co.

Plastics, Industrial 522K — Information on manufacture, grades, properties, fabrication & use of laminated plastic sheets, tubes, rods & special shapes. Illustrated Bulletin. Joseph T. Ryerson & Son.

Platinum, Gold & Silver 414 — Makes available Folder C-20, "Platinum, Gold & Silver for Science, Industry & the Arts" & Folder C-21, "Platinum & Palladium Catalysts." The American Platinum Wks.

Process Equipment, Fabrication 335 — Designed & built around use of Haveg—basic construction material that resists corrosion. Includes size & chemical resistance charts. 64 p. illustrated Bulletin F-6. Haveg Corp.

Refractories 522L — Folder contains brief description of refractory products & their industrial applications for . . . chemical, ceramic, metals, etc. industries. Covers comparative properties. Norton Co.

Roofing & Siding 522M	Data on use of V-Corr—enamel-on-steel roofing & siding material. Covers advantages, composition, colors, methods of installing. Toledo Porcelain Enamel Products Co.
Steels, Aluminized 10	Aluminized steel features valuable advantages: resists high temperatures; resists products of combustion; reflects heat. Complete data in "Armco Aluminized Steel." Armco Steel Corp.
Steels, Stainless 523A	"Stainless Stéel & Textiles" present story of stainless steels used in textile processing, backed by test data on average corrosion rate of different stainless types. Armco Steel Corp.
Steels, Stainless, Welding 523B	"Welding & Soldering of Armco Stainless Steels" covers all types of welding, lists electrode & filler rod recommendations for stainless steels. 52 p. Armco Steel Corp.
Tantalum 399	Immunity to hydrochloric, nitric & perchloric acids, iodine, bromine, etc. eliminates shutdowns, repairs, lost production time, spoilage, etc. Fansteel Metallurgical Corp.

Pipe, Fittings, Valves

Coupling Products, Pipe 523e	Data on fast, flexible, efficient pipe coupling products. Covers couplings for plain end pipe, couplings and precision fittings for grooved pipe, etc. Gustin-Bacon Mfg. Co.
Elbows, Welding 471	Covers 4 different types. Selection gives engineer greater latitude in piping design & permits improvements & economies not otherwise possible. Catalog 54. Midwest Piping Co.
Fittings 249a	Master Catalog describes the complete range of products . . . compressed asbestos sheet packings for all purposes, valves, cocks, level gages, synthetic & silicone rubbers. Klinger Corp.
Fittings 523D	New, hard cover 304 p. general catalog (55) on seamless welding fittings, forged flanges and forged steel fittings. Contains illustrations, dimensions, specifications, etc. Ladish Co.
Fittings, Cast Steel 523E	Immediate shipment of fittings from large stock of standard sizes. Save time in ordering by using convenient selection charts and figure numbers in new Catalog 153. J. B. Beaird Co.
Fittings, Tube 250-1	Designed for applications involving extreme temperatures, corrosion conditions or wherever permanently welded tubing joints are needed. Catalog 4370. Parker Appliance Co.
Hose, Metal, Flexible 443	Varied applications for flexible metal hose & tubing. Shows how designed, used & installed. Includes specifications on tubing & fittings. Booklet CC-400. American Brass Co.
Hose, Plastic 523F	Made from teflon and engineered to withstand highly corrosive fluids from temperatures of —100°F. to +450°F. Covers test results, sizes and construction features. Resistoflex Corp.
Nozzles BR466	Company makes available detailed Catalog describing their Spraco Nozzle line. Includes information on full cone, flat spray, and hollow cone types. Spray Engrg. Co.
Nozzles, Spray R490	Available for every spray job—for acid chambers, air washing, chemical processing, cooling ponds, desuperheating, gas scrubbing, etc. Catalogs 6A & 6C. Monarch Mfg. Wks.
Pipe & Fittings 22-3a	For superior corrosion resistance. Impervious graphite pipe and fittings readily installed, durable, easily maintained, resist corrosive fluids. Catalog S-7000. National Carbon Co.
Pipe & Fittings 38A-B	Recognized as a leader in the field of welding fittings and flanges and as a source of authentic information on piping design. Offers "Pipe and Fitting Materials." Tube Turns.
Pipe & Fittings, Glass 357a	For full-scale production operations. Strengthened by end-tempering, & feature corrosion-resistance, non-contamination, transparency, etc. Catalogs EA-1, EA-3. Corning Glass Wks.
Piping, Copper 51	Costs less to install & maintain: joins quickly; handles easily; won't rust; needs fewer fittings; bends to clear obstructions. Complete details in Publication B-1. American Brass Co.
Tubes, Condenser 247	Includes data on copper alloys, condenser tube corrosion, photomicrographs of grain structure of different metals under varying operating conditions. 28 p. Revere Copper & Brass.
Tubing, Metal, Flexible 174	Scientific application of flexible tubing for air, oil, steam, gases, & volatiles. Engineering data on all tubing & couplings. Illustrated. Pennsylvania Flexible Metallic Tubing Co.
Tubing Pipe 523G	Data on variety of quality tubing—ornamental, mechanical & heat resisting, pressure, sanitary, shaped, etc. Lists applications for each type. Illustrated. Wallingford Steel Co.
Valves 377	20 p. "Take-Home" Handbook deals with the common problems of matching up valve characteristics and specific flow control needs for the most efficient result. Crane Co.
Tubing, Stainless Steel 523H	Flexible stainless steel tubing developed to convery wide variety of searching & corrosive liquids & gases at high temperatures. Illustrated Bulletin STC-1. American Brass Co.
Tubing, Titanium 523I	Data on properties, applications & advantages of titanium tubing. Also covers tubing tolerances, chemical analysis, finishes, etc. Illustrated Bulletin 42. Superior Tube Co.
Valves, Cast Steel 311	For dependable economy in high pressure-higher temperature services. Describes globes, angles, gates, checks with pressure ratings, dimensions and other technical data. Jenkins Bros.
Valves, Check 342	Tilting disc check valves greatly reduce head-loss over standard designed swing-type checks. Covers many features & complete test data in Catalog 30. Chapman Valve Mfg. Co.
Valves, Control 157	For better control of steam & condensates to 2500 psi & 900°F without use of hard-to-maintain special assemblies. Advantages & features in illustrated Catalog 1500 B. Annin Co.
Valves, Diaphragm Control 269	Complete data on company line of diaphragm control valves in Valve Engineering Data Catalog, Bulletin CV53. Also Valve Size Slide Rule Calculator. Kieley & Mueller.
Valves, Flow Control 523J	Solve problems in controlling flow of liquids, refrigerants, gases, & air in equipment & machines. Data on capacity ranges, connection & orifice sizes, lift, etc. A-P Controls Corp.
Valves, Gate 523K	Announces new condensed catalog covering ironbody wedge gate valves. Describes service applications and gives details of construction. Bulletin 107. Kennedy Valve Mfg. Co.
Valves, Gate 164	New design makes forged steel valves the most modern line. Offer stronger stem-to-wedge connection, durable wedges, more efficient union bonnet design, etc. Folder 195. Ohio Injector Co.
Valves, Gate 326	Revolving disc gate valves offer superior operation, durability, less maintenance, etc. Available in wide range of sizes & types . . . pressures to 1500 lbs. Darling Valve & Mfg Co.
Valves, Lubricated Plug 347	New lubricated plug valves offer quick & positive operation—just a quarter-turn to open or close. Available in semi-steel & carbon steel. Detailed literature. Wm. Powell Co.
Valves, Packless 421	For use wherever piplines carrying gasoline, oil, or other volatile liquids and vapors must have positive protection against leakage. Bulletin LC-813. Fulton Syphon Div.
Valves, Pinch, Replacement 523L	Data on replacement valve bodies for pinch-type valves. Abrasion-corrosion—resistant . . . manufactured in rubber, neoprene, butyl, buna N, etc. Bulletin 345. General Rubber Corp.
Valves, Plug 353	Equipped with special-coated plug . . . for superior performance. Special coating assures tight seal & is highly resistant to abrasion & corrosion. Ofers Catalog. Wedgeplug Valve Co.
Valves, Porcelain 43	Company makes available literature covering advantages and features of porcelain valves. Includes full description, characteristics and specifications. Lapp Insulator Co.
Valves, Pump 390	Pump valves will operate freely under extremes of high or low temperature, with highly corrosive fluids, and in any position. Bulletin offer full details. Durabla Mfg. Co.
Valves, Refrigeration 523M	28 p. Product Application Manual with charts, installation drawings & data on all types of refrigeration valves, filters. Operation, applications, capacities. A-P Controls Corp.
Valves, Relief 523N	For steam, air & gas service. Offer valuable features: maximum safety; overpressure regulation; savings; ease of adjustment. Charts, diagrams, tables, photos, etc. Cochrane Corp.
Valves, Selector 308A	Truly "balanced" selector valve has just been perfected which handles pressures up to 6000 psi with an ease of valving never before attained. Data in Bulletin 454. Republic Mfg.
Valves, Solenoid TR468	Covers new line of cast iron & cast steel solenoid valves in sizes from ⅛" to 2". Pressures range to 1000 psi at 200°F., 500 psi at 450°F. Bulletin 106. Atkomatic Valve Co.

Electrical & Mechanical

Battery Care, Storage 523O	Presents a pocket-sized booklet which breaks down battery care to seven basic rules, each emphasized with cartoon treatment & clear, concise text. Electric Storage Battery Co.

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Technical Literature, cont. . . .

Bearings 523P — Issues bearing application evaluation chart . . . designed to enable engineers to evaluate their bearing functions with respect to 17 service requirements. Thomson Industries.

Belts, V- 524A — New detailed Brochure provides engineering & design data on multiple v-belts. Includes a comprehensive explanation of fundamentals of v-belt design. Goodyear Tire & Rubber Co.

Cleaners & Expanders, Tube 406a — Tube cleaners & tube expanders keep tubes at peak efficiency, reduce down time due to tube failures. Quickly remove hardest deposits from straight or curved tubes. Airetool Mfg. Co.

Conduit, Electrical, Corrosion-Proof 301 — Chemical resistance of Electrunite "Dekoron-Coated" E. M. T. in addition to information on how to install it, covered in Booklet DEK-1. Steel & Tubes Div., Republic Steel Corp.

Drives, Adjustable-Speed 524B — New stepless adjustable-speed drive . . . designed for operation from A.C. power lines & is available with D.C. drive motors in standard NEMA frame sizes, ½ to 15 hp. Louis Allis Co.

Drives, Chain, Silent 524C — 88 p. offers detailed engineering data. Covers features & advantages of silent chain drives, types of silent chain, types of silent chain wheels, etc. Book 2425. Link-Belt Co.

Drives, Fluid 99 — Adjustable-speed fluid drive features unlimited application possibilities, with its wide-range, stepless speed, reversible control. Details in Bulletin 9419. American Blower Corp.

Drives, Variable Speed 524D — Offer many features: larger speed range; simple construction; positive locking; higher efficiency; less shaft overhang; no lubrication; economy; etc. Bulletin 796. T. B. Wood's Sons.

Electrical Modernization 524E — Electrical modernization in industrial plants. Principal elements of modern electrical system described & their advantages outlined. Booklet B-6133. Westinghouse Elec. Corp.

Electric Plants, Stand-By 524F — Teflon expansion joints and flexible couplings absorb shock, vibration, thermal expansion and contraction. Connect unlike piping ends and nozzles. Bulletin FC-952. U. S. Gasket Co.

Joints & Couplings 417 — Covers the installation of emergency stand-by electric generating plants and automatic line transfer controls, in illustrated and detailed Technical Bulletin T-011. D. W. Onan & Sons.

Magnetic Transmission Equipment 524G — Provides a ready reference for figuring the right transmission equipment for individual applications. Diagrams, dimensions, capacities, etc. Bulletin 226-C. Stearns Magnetic.

Motor Control, Synchronous 93 — Includes data on these 3 pertinent features: graduated squirrel-cage protection; precision angle switching; load angle field removal. Bulletin GEA-5873. General Elec. Co.

Motor Starter—Circuit Breakers 270-1 — Explosion-proof, dust and rain—tight circuit breaker and motor strater Unilets offer superior design, construction and performance. Details in Bulletin BH. Appleton Elec. Co.

Motors 287 — Require least maintenance . . . stay on the job longest . . . deliver peak performance under the most severe operating conditions. Full details in Bulletin CE3304. Diehl Mfg. Co.

Motors 36-7 — Motor economy with new features . . . proved principles. Bearing design gives greater bearing protection, ease of maintenance, long life. Bulletin 51B6210. Allis-Chalmers Mfg. Co.

Motors 433 — Extra dependability of Electro Dynamic motors covered in new report, "Motor Showdown." Includes data on comparative results of motor performance tests. Electro Dynamic Div.

Motors 108-9 — Covers Life-Line "A" motors—new insulating materials, new stator core, new cooling methods, new precision manufacturing techniques. Booklet B-6154. Westinghouse Elec. Corp.

Motors, Fan-Cooled 334 — Cartridge bearing design lowers maintenance: bearings protected at all times . . . can be relubricated . . . run longer between grease periods. Bulletins MU-132, MU-196. Wagner Elec. Corp.

Motors, Gear 163 — Feature new dependability, greater starting torque and top efficiency, with output speeds as low as 7.5 rpm. Contains full information in Bulletin GM-1. Howell Elec. Motors Co.

Packings, Ring, Automatic 330 — For long service life as well as foolproof operation . . . offer advantages for use in pump rods & plungers, compressors & similar equipment. Booklet PK-58A. Johns-Manville.

Packings, Teflon 386 — Cut packing replacement & maintenance costs. Stop leakage by providing tight seal at only slight gland pressure. Teflon Packing & Gasket Catalog. Chemical & Power Products.

Packings, Teflon 524H — Presents data on Dura Plastic teflon packing . . . its latest development in solving the sealing problems of handling corrosive chemicals. Bulletin 461. Durametallic Corp.

Power Transmission Equipment 524I — 24 p. illustrated Catalog with data on variable speed pulleys, wide v-belts, sheaves, motor bases, countershafts & Select-O-Speed transmission. Lovejoy Flexible Coupling Co.

Reclaimer Systems, Oil L432 — Offers information on a simple, economical, efficient method of restoring contaminated lubricating & sealing oil to full value of new oil. Purifier Div., Hilliard Corp.

Rings, O-, Metallic 524J — Deals with the vented and standard "O" Rings and the various industrial applications for static sealing of high and low pressures and temperatures. United Aircraft Products.

Sheaves, Variable Pitch 524K — Offers illustrated Bulletin describing the company line of variable pitch sheaves and special drives. Includes photos, demensional drawings, charts, etc. Speed Selector.

Sprockets, Roller Chain 90 — Save time & money through use of roller chain sprockets with taper lock bushings. Faster, less expensive procurement . . . installation & removal. Details in Book 2449. Link-Belt Co.

Teflon Products 389a — Data on Teflon parts & products in illustrated 12 p. catalog. Includes bellows, bellows connectors, pump & valve packings, tubing & other molded forms. Crane Packing Co.

Turbines 524L — 20 p. on line of Type E turbines in ratings thru 1500 hp. Covers design & constructional characteristics, accessories, applications. Booklet B-3896. Westinghouse Elec. Corp.

Heating & Cooling

Boilers 361 — Offer many advantages & quality features . . . at economical cost—4-pass firetube construction; silent operation; fast, easy maintenance; etc. Illustrated. Cleaver-Brooks Co.

Boilers, Packaged Automatic 345 — For light oil, heavy oil, gas or combination gas-oil firing. Sizes to 500 hp; pressures to 250 psi. Covers constructional & operational advantages. Illustrated. Orr & Sembower.

Coils, Blast 422 — Feature no clogging . . . no freezing . . . no temperature strains . . . no short-circuiting. Complete Chinook heater story in 24 p. Bulletin CH-532. Bayley Blower Co.

Coolers, Air-Quenching 38a — Describes how savings can be effected in cement, lime & chemical industries thru use of an air-quenching shaking grate cooler. Illustrated Bulletin 07B7869. Allis-Chalmers Mfg. Co.

Coolers, Cascade 357b — Corrosion-resistance prevents chemical attack inside tubes & permits use of river or sea water as coolant. Heat transfer nomographs, tables, etc. Bulletin PE-8. Corning Glass Wks.

Coolers, Evaporative Water 318 — Efficient heat exchange with minimum cooling water. Feature "Q" factor—built-in quality which provides trouble-free satisfaction & long life. Bulletin 3666A. Buffalo Forge Co.

Drying, Flash 378 — Feature valuable advantages: low first cost; ease of installation; close product control; economies in operation & maintenance; etc. Descriptive Catalog 54-A. Raymond Div.

Generators, Steam L451 — Economical, efficient—produce steam for process or heat. Fire-tube (20-600 b.h.p.), Catalog 622-F. Water-tube (200-1000 b.h.p.), Catalog 622-W. Superior Combustion Industries.

Heat Exchangers 530 — 40 p. designed to help solve heat exchanger problems. Contains data needed to work out capacity & type—arranged in tables, curves, charts. Manual 837. Pfaudler Co.

Heat Exchangers 22-3b — Offer chemical resistance to practically all corrosive fluids; resistance to severe thermal shock; high heat-transfer rates; low maintenance; etc. Catalog S-6740. National Carbon Co.

Heat Echangers 72 — Makes available complete technical information regarding De Laval plate heat exchangers for heating, cooling or regeneration, in detailed Bulletin PHX. De Laval Separator Co.

Heat Exchangers 382 — High efficiency impervious graphite heat exchangers feature highest quality workmanship & design. Available for single & multi-pass applications. 12 p. Falls Industries.

Heaters, Air 398 — Direct fired air heaters offer many features: compact & flexible; simplified controls; low maintenance; high efficiency; etc. Use & operation in Bulletin 600-E. Peabody Engrg Corp.

Heaters, Air 418 — Readily fitted to ovens, kilns, spray dryers, etc. . . . an ideal source of heat where products of combustion may be mixed with air. Bulletin 104. Thermal Research & Engrg. Corp.

Heaters, Electric Radiant 524M — Factual presentation of use of Chromalox Far-Infrared radiant heaters for controlled, high-speed drying & curing of synthetic textile finishes. Illustrated. Edwin L. Wiegand Co.

Heaters, Electric, Tubular 524N — Simple, efficient, durable . . . practical heater for all fluids. Covers component parts—pipe, resistors, insulators, strap, terminal box. Illustrated Bulletin 202. Hynes Elec. Heating Div.

Heaters, Electric, Woven 525A — Describes and illustrates woven electric heaters —includes typical uses and gives application data for this new versatile heat source. Folder F-1548. Pre-Fab Heater Co.

Heating, Dowtherm 427 — Illustrated 28 p. includes useful engineering data, 136 different types & sizes to choose from, 9 different complete system layouts, etc. Bulletin A-100. Eclipse Fuel Engrg. Co.

Platecoils 44 — For tank heating & cooling problems due to inefficient pipe coils. Cost-saving Platecoils heat or cool 50% faster & take 50% less space in the tank. Bulletin P61. Tranter Mfg.

Refrigeration 391 — Hundreds of different industrial applications of cooling systems now in operation throughout the world. Company makes available literature and quotations. Frick and Co.

Traps, Steam 525B — For faster heating up, more production, lower steam consumption, longer trap life, reduction in trap capacity factor. Specifications & capacities. Bulletin 1153. V. D. Anderson Co.

Traps, Steam 139 — Offers 32 p. standard reference complete with installation diagrams as well as charts and formulae for determining proper size of trap. Trap Catalog 953. W. H. Nicholson & Co.

Handling & Packaging

Aerosol-Packaged Products 525C — Presents latest du Pont Aerosol market survey, "The Aerosol Market," a study of consumer knowledge, use & opinion of Aerosol-packaged products. E. I. du Pont de Nemours & Co.

Boxes, Corrugated 525D — For economical protection . . . prominent identification . . . sales-winning promotion. Offers details in booklet, "How to Merchandise with Corrugated Boxes." Hinde & Dauch.

Closures, Polyethylene 525E — Evaporation-proof, leak-proof . . . never bind or back-off. Since there is no "material fatigue" or breakdown, resealing value is unequalled. Illustrated Booklet. Poly-Seal Corp.

Conveyors 525F — New folder composed of 20 case history field reports which demonstrate factually how conveyors cut production overhead for industries which use them. Speedways Conveyors.

Conveyors, Vibrating 525G — Describes Oscilveyor vibrating conveyor—how it operates & features which make it desirable for handling fine granular materials. New, illustrated Bulletin. Gifford-Wood Co.

Drums 315 — Tight head or removable head types . . . protect sensitive chemicals, oils, & food products against contamination during shipment or in storage. Offers Catalog. Pressed Steel Tank Co.

Feeders, Belt Gravimetric 463 — Push button control from central control panel for continuous compounding of dry materials. Feeders totally enclosed, dust-tight, etc. Bulletins 35-G5, 35-F5B. Omega Mach. Co.

Gluers & Sealers 57 — Greatly increase number of cases that can be prepared for shipment within a given period. Wide choice of models to meet exact requirements. Offer catalogs. Standard-Knapp Div.

Materials Handling 333 — 32 p. Brochure covers in brief, case-history fashion a broad range of engineered materials handling installations in a variety of industries. Illustrated. Gifford-Wood Co.

Materials Handling, Bulk-Flo 13 — For reduced handling costs on wide range of materials. Features ability to feed, convey, elevate in one compact, fully enclosed assembly. 28 p. Bulk-Flo Book 2475. Link-Belt Co.

Paving Breakers 525H — New descriptive literature includes features and specifications on Gardner-Denver heavy-duty, medium-weight and lightweight paving breakers. Bulletin PB1. Gardner-Denver Co.

Pulleys, Magnetic 48 — Magnetic pulleys protect equipment in a coal preparation plant against bolts, spikes, cutter bits & other stray iron. Details in Bulletin C-5000-B. Dings Magnetic Separator Co.

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6b	27a	56	82	127	152D	243c	294–5d	310A	330	357c	388a	413	446	BL466	M490b	518W	519Z	521M	524C
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Technical Literature, cont. . . .

Ramps, Dock 525I	Complete data on non-floating 10,000 lb.-capacity hydraulic adjustable ramp designed as a bridge between dock loading platforms & the beds of highway trucks. Rowe Methods.
Scales 429	Offer numerous advantages in solving bagging, batching, checkweighting problems involving powder, pellets or dry mixes. Data in Bulletins. Thayer Scale & Engrg. Corp.
Scoops, Power, Automatic 526A	For safe, speedy, 1 man operation in unloading bulk material from box cars. Lists outstanding features, dimensions & specifications in illustrated Bulletin 862. Jeffrey Mfg. Co.
Separators, Magnetic 526B	Data on magnetic separators for the process industries . . . for the removal of iron contamination from wet and dry materials. Details in illustrated Bulletin. S. G. Frants Co.
Spaders, Clay 526C	Describes and gives the specifications for Gardner-Denver clay spaders, trench diggers, and single pad and triplex backfill tampers, in new Bulletin ST-100. Gardner-Denver Co.
Tanks B448	Stainless steel tanks for your processing—maintain stock or fabricate to special designs for your particular need. Any size—any capacity up to 2000 gallons. Filpaco Industries.
Tractor-Loaders 291	Feature the numerous advantages of loading with the combination of clutch-type transmission and hydraulic torque converter. Makes available detailed literature. Tractomotive Corp.
Tractor-Shovels 75	Feature superior bucket action . . . handle bigger loads, move more yardage—faster, at considerably lower cost. Specifications & action photos in Fact-Folio. Clark Equipment Co.
Tractors, Towing 526D	Offer greater ease of control, convenience & usefulness without sacrificing basic features. Details on tractors for airports, plants, yards & docks. Frank G. Hough Co.
Trucks, Fork 526E	Electric powered, 10,000 lb. capacity trucks offer dependable & economical operation under severest operating conditions. Details in illustrated Folder. Elwell-Parker Elec. Co.

Processes, Services, Misc.

Autopositive Paper 66	Company makes available illustrated booklet, "Modern Drawing and Document Reproduction," offering valuable information on line of Kodagraph materials. Eastman Kodak Co.
Combustion, Catalytic 526F	Low temperature oxidation process by which many fumes from industrial processing are converted to odor-free, color-free gas plus useful heat energy. Catalytic Combustion Corp.
Fire Protection, Foam 160	Illustrated booklet with data on the advantages of foam. Tested on petroleum or polar-solvents fires. Checked as to extinguishment time, foam volume, sealability. National Foam System.
Ground Water Development 277	Largest developers of ground water resources. Service includes exploration—drilling—modernization—maintenance & installation of Layne equipment. Bulletin 100. Layne & Bowler.
Oxygen Plants 151	Blaw-Knox-built, Linde-Fraenkl units produce more oxygen of greater purity at the lowest total operating cost of any tonnage oxygen plants available. Bulletin 2402. Blaw-Knox Co.
Papers, Fiberglas 526G	Illustrated, 16 p. booklet, "Fiberglas Products for Papermaking," designed as a useful guide to the formulation & production of Fiberglas papers. Owens-Corning Fiberglas Corp.
Petro-Basic Production 156	Uniformity, purity, price stability of synthetic production . . . continuity of petrochemical operation, based on integrated raw material supply . . . etc. Celanese Corp. of America.
Urea Process, Pechiney 135	Low cost, minimum corrosion process . . . features a neutral oil circulating medium for recycling of unconverted ammonia-carbon dioxide. Details in Bulletin 0-54-3. Foster Wheeler Corp.
Water Treatment 526H	Water Treatment for cooling towers. Types of cooling systems together with such problem as corrosion of metal surfaces, inorganic scaling, etc. Bulletin 28X7501A. Allis-Chalmers Mfg. Co.

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CHEMICALS

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Bond, corrosion-proof 154C
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Cleaner, phosphate 158B
Coal chemicals 158A
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Foam, moldable plastic 156B
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Isocyanate, foamed-in-place 160H
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Plasticizers, vinyl 158C, 160D
Polypropylene glycols 150A
Resins, insulation epoxy 154D
Rubber, silicone 154B
Sulfates, sodium lauryl 160E
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Aluminum, coated 268C
Belts, V 274E
Compressors, recycle 266C
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Conveyors, dual trough 278C
Detectors
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Magnets, hopper 276E
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Unloaders, scoop 276D
Valves 266A
Vapor caps 276C
Viscometers 270A
Warning systems 278E
Windows, plastic safety 280E

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6a	26e	55	81b	125e	152C	243b	294–5c	309	329	357b	387b	412	445	TL466	M490a	518V	519Y	521L	524B			
6b	27a	56	82	127	152D	243c	294–5d	310A	330	357c	388a	413	446	BL466	M490b	518W	519Z	521M	524C			
6c	27b	57	83	129	152E	243d	294–5e	310B	331	358	388b	414	TL447	TR466	M490c	518X	519AA	521N	524D			
6d	27c	58	84	131	152F	243e	294–5f	310C	332	359	388c	415	BL447	BR466	R490	518Y	519BB	521O	524E			
8	28–9a	59a	85	133	152G	243f	294–5g	310D	333	360a	389a	416a	R447a	TL468	491	518Z	519CC	522A	524F			
9	28–9b	59b	86	135	152H	245	296A	310E	334	360b	389b	416b	R447b	BL468a	508	518AA	519DD	522B	524G			
10	28–9c	60	87a	137	153	247	297	311	335	360c	389c	417	R447c	BL468b	509	518BB	519EE	522C	524H			
11a	30–1	61	87b	139	154	249a	298A	312A	336	360d	389d	418	T448	BL468c	510	518CC	519FF	522D	524I			
11b	32–3	62a	87c	140–1a	155	249b	299	312B	337–8a	361	390	419	B448	BL468d	511	518DD	519GG	522E	524J			
11c	34	62b	88	140–1b	156	249c	300A	312C	337–8b	364	391	420a	L449	TR468	512	518EE	519HH	522F	524K			
11d	35	63a	89	140–1c	157	249d	300B	312D	337–8c	365	392	420b	R449	BR468	B513a	519A	519II	522G	524L			
11e	36–7	63b	90	140–1d	158	250–1	301	312E	338A–B	366	393	421	L451	469	R513b	519B	519JJ	522H	524M			
12	38a	63c	91	140–1e	159	255	302A	312F	339	367a	394a	422	M451	TL470	B513c	519C	519KK	522I	524N			
13	38b	64	92	140–1f	160	257	302B	313a	340	367b	394b	423	R451	BL470	518A	519D	520A	522J	525A			
16–9a	38A–B	65	93	140–1g	162	258–9	302C	313b	341a	367c	394c	424	L452	471	518B	519E	520B	522K	525B			
16–9b	39	66	94	140–1h	163	261	302D	313c	341b	367d	395	425	M452	472	518C	519F	520C	522L	525C			
16–9c	40	67a	95	142A	164	263	302E	313d	342	367e	396	426	R452	L473	518D	519G	520D	522M	525D			
16–9d	41	67b	98	143	165	266	303	313e	343	368a	397	427	453	TR473	518E	519H	520E	523A	525E			
16–9e	42a	67c	99	145	167	267	304A	314A	344	368b	398	428	TL456	BR473	518F	519I	520F	523B	525F			
16–9f	42b	68	100	146A	168a	269	304B	314B	345	368c	399	429	BL456	TL474	518G	519J	520G	523C	525G			
16–9g	42c	69	101	146B	168b	270–1	304C	314C	347	368d	400	430	R456	BL474	518H	519K	520H	523D	525H			
20–1	43	70	102	147	168c	273	304D	314D	348	369	401a	431	457	BR474	518I	519L	520I	523E	525I			
22–3a	44	71	103	148A	168d	275	304E	314E	349	370	401b	L432	L458	475–8a	518J	519M	520J	523F	526A			
22–3b	45	72	104	148B	168e	277	305a	315	350	371	402	M432	TR458	475–8b	518k	519N	521A	523G	526B			
22–3c	47a	73	107	148C	168f	279	305b	317	351a	376	403	433	BR458	475–8c	518L	519O	521B	523H	526C			
22–3d	47b	73A–B	108–9	148D	168g	280–1a	306A	318	351b	377	404	434	L460	475–8d	518M	519P	521C	523I	526D			
22–3e	47c	74	113	149	169	280–1b	306B	319	352	378	405	435	TR460	475–8e	518N	519Q	521D	523J	526E			
22–3f	47d	75	117	150A	170	283	306C	320	353	380	406a	436	BR460	475–8f	518O	519R	521E	523K	526F			
22–3g	48	76	119	150B	171	285a	306D	321	354	381	406b	437	461	479–80	518P	519S	521F	523L	526G			
22–3h	49	77	121	150C	172	285b	306E	322	355a	382	406c	440	L462	L481	518Q	519T	521G	523M	526H			
22–3i	50	78	123	150D	173	287	307	324	355b	383	407	441	TR462	TR481	518R	519U	521H	523N	526I			
26a	51	79	125a	150E	174	291	308A	325	355c	384	408	442	BR462	482	518S	519V	521I	523O	529			
26b	52	80a	125b	151	175	293	308B	326	355d	385	409	443	463	489a	518T	519W	521J	523P	530			
26c	53	80b	125c	152A	176	294–5a	308C	327	356	386	410											

. . . And these items in the Reader Service "Flashback" Section (p. 527)

150A	154B	156A	158B	160B	160E	160H	264B	266C	268B	268E	272A	272D	274C	274F	276C	278A	278D	280B	280D
152A	154C	156B	158C	160C	160F	262A	266A	266D	268C	270A	272B	274A	274D	276A	276D	278B	278E	280C	280E
154A	154D	158A	160A	160D	160G	264A	266B	268A	268D	270B	272C	274B	274E	276B	276E	278C	280A		

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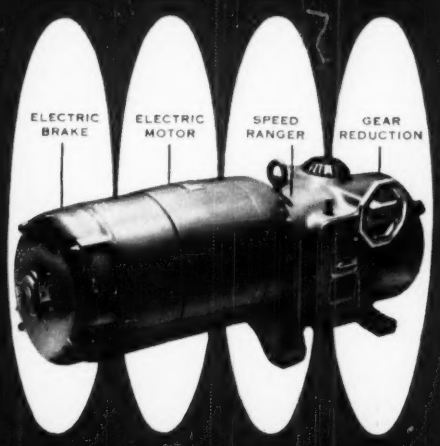

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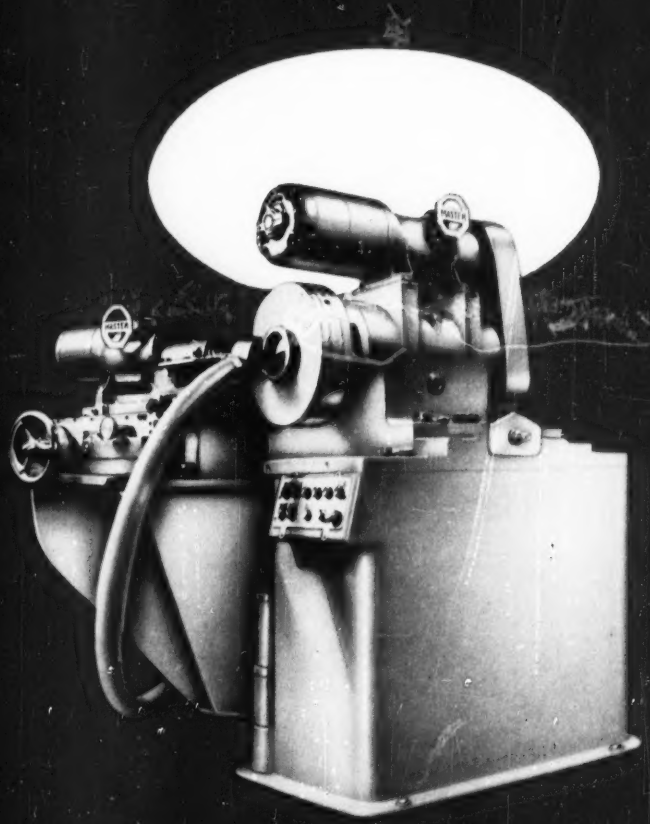

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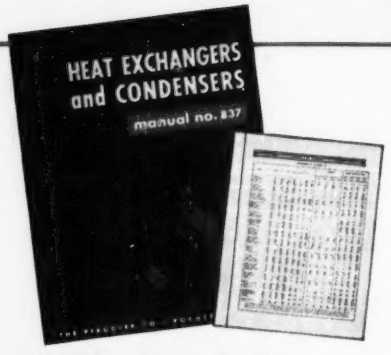

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